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Original Communications.

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F.* (*January to August*, 1916)].

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AND

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CONTENTS.

INTRODUCTION.

THE work carried out in Egypt of which this paper forms the report was undertaken at the request of Surgeon-General Sir William Babtie, V.C., K.C.M.G., at that time P.D.M.S., M.E.F., in consultation with the Medical Advisory Committee. Its object was threefold, namely, an investigation into the carrier problem of amœbic dysentery amongst the troops with a view to the possible elimination of the carriers; secondly, an inquiry into the best method of administering emetin to carriers and actual dysenterics with the object of establishing some uniform line of treatment which would give the maximum of good result; and, thirdly, an examination of the fly transmission of amœbic dysentery by means of cyst carriage, and a determination of the best means of destroying the resistant amœbic cysts after their escape from the body.

During the inquiry into the three problems named above, although our attention was chiefly directed towards the pathogenic *Entamœba histolytica*, all the various intestinal protozoa of man in Egypt came under observation, and we have been able to gather a large amount of information regarding them. Much of this is quite new and it will be set forth in the following pages under different headings.

The work was carried out at Alexandria, as Surgeon-General Babtie rightly considered this to be the most suitable locality for an investigation of this kind amongst troops in camp. We were fortunate at the outset in obtaining a very excellent laboratory at the Orwa-el-Waska Section of the 19th General Hospital, where Lieutenant-Colonel Scott, R.A.M.C., officer commanding in charge, and Captain Lambkin, R.A.M.C., Registrar of 19th General Hospital and officer commanding at Orwa-el-Waska, gave us every assist-

ance. It is not too much to say that without the help of these officers and their readiness on every occasion to carry out our wishes, the work we had in hand could not have been so successfully conducted. For the treatment of the cases we had two dysentery wards at our disposal, and we were able to observe closely the course of the various infections and the effect of treatment. The late Lieutenant-Colonel Lister, C.M.G., R.A.M.C., Medical Superintendent of the hospital, who always showed a lively interest in our investigations, very kindly allowed us to take over the treatment of all the amœbic or other protozoal infections, so we had ample material on which to work.

In addition to the cases which were identified by us in the routine examination of all the hospital admissions, we obtained a larger number of cases from the examinations of apparently healthy men in various camps around Alexandria. As will be shown below we found a fairly high percentage of carriers amongst the healthy or apparently healthy men and these were brought into hospital and given a course of emetin, the result of which will be discussed in another part of this paper.

The carrying out of the routine examinations of men in camp seemed at first sight a very difficult procedure, but a system was elaborated which proved to be reliable chiefly owing to the interest shown by Captain Sibley, R.A.M.C., then Sanitary Officer to one of the camp areas, who helped us in every possible way and rendered easy what appeared at first sight an almost impossible undertaking. The working of any scheme for the collection of material from men in camp is no easy matter. Yet the energy and skill of Serjt. E. Weavis, R.A.M.C., specially detailed for laboratory duty, enabled us to collect several thousand specimens without any mistake or hitch in the proceedings.

In order to obtain an insight into the intestinal protozoa of the natives of the country, with a view to the discovery of a reservoir of infection, we were kindly given permission by Dr. Kirton, Medical Superintendent of the Egyptian Jails, to examine a series of over 500 prisoners in the Hadra Prison, Alexandria. These observations afforded most interesting results which will be detailed below.

The patients in hospital were under the care of a medical officer who carried out the treatment suggested by us. For the greater part of the time Lieutenant Eastmond, R.A.M.C., was in charge and our thanks are due to him for the trouble he took with our cases. As will be explained below they were controlled very

carefully, at least one entire stool from each being inspected daily. We obtained detailed histories from all the cases, especially as regards the possibility of past dysentery or emetin treatment, and the occurrence of any symptoms during the observation was carefully noted. In the laboratory work connected with these hospital cases which involved blood examinations, bacteriological culture work, collection of material and obtaining information from the patients, we have been very much helped by Cpl. W. J. Muggleton, R.A.M.C., who was senior laboratory assistant at the Wellcome Bureau of Scientific Research before he left for active service abroad, in connexion with our work.

When the hospital cases had completed their course of treatment it was necessary to keep them under observation for some time. An arrangement was made whereby a section of the convalescent depot at Mustapha was set apart for their reception. From these cases Serjt. Weavis collected specimens on alternate days for at least one month, so that we were able to note at once when any relapse of the infection occurred. Major Fisher, R.A.M.C., Officer Commanding the Convalescent Depot at Mustapha, made all arrangements for the reception of our cases, and we are greatly indebted to him for the trouble he took and the care with which our wishes were carried out.

We wish also to express our indebtedness to Colonel Beach, C.M.G., A.D.M.S., at Alexandria, for the interest he took in our inquiry and for the help and assistance he constantly gave, especially in smoothing our path in the carrying out of what were sometimes rather difficult and intricate negotiations. Finally, we wish to acknowledge the help we received from Colonel Sandwith, C.M.G., whose wide Egyptian experience and the position he held as Consultant Physician to the Military Hospitals in Alexandria, rendered his assistance and encouragement most valuable.

PART I.

The Incidence of Protozoal Infections amongst British Troops and Natives in Egypt with Special Reference to the Carrier Problem of Amœbic Dysentery.

The examinations for intestinal protozoa were carried out upon several classes of men, including healthy British troops on full duty in camps round Alexandria, healthy British and British West Indian cooks employed in the same localities, British convalescents in the convalescent camp at Mustapha, healthy native prisoners in

the Hadra Prison, British prisoners in Gabarri Prison, the permanent Royal Army Medical Corps staff of the Convalescent Depot at Mustapha, the Royal Army Medical Corps staff of the Orwa-el-Waska Section of the 19th General Hospital, and all the cases admitted to the Orwa-el-Waska Hospital for dysentery and other intestinal disorders, the majority of the latter coming from various stations in Egypt, but some being invalids from Mesopotamia. The various findings in these several groups will be discussed below, but first of all we will describe the methods of our examinations and the value of these in determining a correct percentage of the various infections.

Method of collecting Material.

In the case of hospital patients there is no difficulty in obtaining samples of the stool for examination. We arranged that the entire stool was brought for inspection in a bed pan, a much more satisfactory procedure than when only a small sample is sent from the ward in a tube. An inspection of the entire stool gives a much more accurate idea of the condition of the patient. When only small samples are sent small quantities of blood and mucus are liable to be overlooked and one fails to get a correct notion of the character of the entire stool. In order to do this it is essential to have some room or lavatory near the laboratory to which pans can be brought for inspection.

When it comes to the collection of material from men in camps or prisons much greater difficulties have to be encountered. These can only be surmounted by interesting the men in the proceedings and it is essential to have some reliable person in authority to carry out the arrangements and to control the men. We were fortunate in having the services of Serjt. Weavis, who carried out his duties admirably. Arrangements were made through the sanitary officers of the camps or prisons who saw that a special latrine or screened area was set apart for the purposes of collection. Within the enclosure were arranged in a row a series of "stool closets," which are small zinc pans each supported on an iron ring on four metal legs. There is a wooden seat round the pan. We found that a couple of dozen of these were ample for working purposes. The men from whom samples are to be collected are paraded, preferably directly after breakfast, near the enclosure. They are then instructed, numbered off and told to use the stool closet corresponding to their numbers. The men are ordered not to micturate into the pan, into which only fæces are to be passed. Each man is given a collecting tube with a metal spoon attached

to the cork or some other receptacle and when he has eased himself he takes a sample of the stool on the metal spoon and places it in the tube. During the proceedings it is necessary to have an orderly, who understands the work, on duty in the latrine to see that the men carry out the process properly and do not attempt to mix up the samples either by accident or intentionally. The men carrying the tubes line up outside and the name of each is written on the tube while the serjeant obtains any information such as history of dysentery, previous foreign service and so on. Meanwhile a number of cleaners are occupied with the zinc pans and when they are properly cleaned and dried they are replaced and another series of men instructed to repeat the procedure. In this manner in a very short time it is possible to collect reliably fifty or sixty specimens. It is not possible, of course, to collect a sample from every man paraded, for a certain number of men will be unable to oblige. The "defaulters" can be again paraded with a fresh lot of men the following morning. This method of collection we have used regularly and it has yielded very good results. The men who were found to be carriers of *E. histolytica* were ordered into hospital for treatment, and though this was done on the evidence of a single sample collected in the manner described above in no case did an error arise in the matter of bringing the wrong man into hospital.

We have described the method in some detail, because, when it was at first suggested that we should collect samples from healthy men it was thought that the difficulties to be overcome would be insurmountable. Furthermore, the method could be employed for the collection of samples for many other purposes, as, for instance, examinations for typhoid carriers.

In all the examinations of men in camp we have examined only single samples from each man. We recognize that in so doing a number of cases of infection are missed, for the protozoal infections of the human intestine are very irregular as judged by the appearance of the protozoa in the stool.

The Value of a Single examination in determining Infections.

If one looks through the protocols of the cases of *E. histolytica* infection at the end of this report it will at once be seen that many protozoal infections which were not apparent at the first examination of a patient's stool appeared later on. This was true of all the protozoa found in the intestine. On several occasions cases which have been treated for a lamblia or other

infection have, during the control, suddenly given evidence of an infection of *E. histolytica*. Such observations prove to us clearly that a single examination of any individual may give an erroneous view of the infection. In order to arrive at some idea of the error we undertook the examination of a group of healthy men. The permanent Royal Army Medical Corps staff of the Mustapha Training Depot were chosen for this purpose. A series of ninety-two men were examined for a number of days. It was intended originally to examine them all every day, but owing to the changes in the staff and the movements of troops this was impossible. However, some of the men were examined twelve times, others eleven, others ten, and so on during the twelve days, and the results have been arranged in Table I, in the order of the number of examinations. In the first column have been placed the complete findings resulting from all the examinations and in the twelve columns following the result of the daily examinations. Thus case Thomas was found to have *E. coli* cysts (E.c.c.), *E. histolytica* cysts (E.h.c.), free amœbæ (E.f.), lamblia cysts (L.c.), *E. nana* cysts (E.n.c.), and *E. nana* free (E.n.f.). On the first examination, however, were found only *E. coli* cysts, lamblia cysts and *E. nana* cysts, and it was not till the sixth examination that *E. histolytica* cysts appeared. It will be noted that the majority of cases examined yielded results of this kind. Thus looking at the *E. histolytica* infections alone it will be seen that this parasite was found in twelve of the ninety-two cases, but that in only four of these was it found at the first examination. If we are to accept this finding it would mean that all the figures resulting from a single examination would have to be multiplied by three in order to arrive at a correct result. Whether this is too high an estimate future investigations will show, but it seems to us that the findings of a single examination are far below what they really should be and that to triple the figures would give a result much more nearly accurate. The findings amongst the various groups to be described now are all based on the single examination with the possible exception of a very small number of the hospital cases which have been examined two, three, or even more times. It will be realized that the figures, though they may appear high, are very much lower than they would have been if the examinations had been repeated.

One important point requires mentioning and that is the possibility of the errors of a single examination being less when the organism is the actual cause of disease. For instance, when

TABLE I.—A SERIES OF CASES TO ILLUSTRATE THE ERROR INVOLVED IN A SINGLE EXAMINATION—INFECTIONS WHICH ARE NOT APPARENT AT THE FIRST EXAMINATION APPEAR LATER. THE COMPLETE FINDING APPEARS IN COLUMN A, THE DAILY FINDINGS IN COLUMNS 1 TO 12.

	A	1	2	3	4	5	6	7	8	9	10	11	12
Pavis	E.c.c.	–	–	–	–	+	+	–	+	–	–	–	–
	E.f.	–	+	–	+	–	+++	–	–	–	+	–	–
Howard	E.c.c.	+	..	+	+	–	–	–	–	–	+++	+	–
	E.f.	–	..	–	–	+	–	+	–	–	–	–	+
Beaumont ..	E.c.c.	–	++	–	+++	+	–	..	–	+	++	–	+
	E.f.	–	–	–	–	–	–	..	+	+	–	–	–
	Tet. c.	–	–	++	–	–	–	..	–	–	–	–	–
	Tet. f.	–	–	++	–	–	–	..	–	–	–	–	–
Bamford	E.n.c.	–	–	–	–	–	–	–	..	–	+	–	+
Thomas	E.c.c.	+++	++	+	–	++	–	–	–	+	–	..	+
	E.h.c.	–	–	–	–	–	++	–	+	+	+	..	–
	E.f.	–	–	–	+	–	+	+	–	–	–	..	–
	L.c.	++	+	+	–	+	+	+	++	+	+	..	+
	E.n.c.	+++	–	+	+	++	++	–	++	+	+++	..	+++
	E.n.f.	–	+++	–	+	–	–	–	–	–	–	..	–
Reenie	–	..	–	–	–	–	–	–	–	–	–	–	–
Licrave	E.c.c.	++	–	+	+	–	–	–	–	–	++	+	–
	E.f.	–	–	–	–	+	–	+	–	–	–	+	–
Wellwood	E.c.c.	+	++	++	++	+	++	..	+	..	+	+	+
Hewlett	E.c.c.	+	++	+	..	–	+	+	+	–	..	–	–
	E.f.	–	–	–	..	–	+	–	–	+	..	+	+++
	E.n.c.	–	–	–	..	–	–	+	–	–	..	–	–
Price	Trich.	–	..	–	+	–	–	–	–	–	–	..	–
Ferrie	Tet.c.	+++	+++	+	–	–	–	–	..	–	–	++	..
	Tet.f.	–	+++	+++	+++	+++	++	+++	..	+++	+++	–	..
Bailey	E.c.c.	–	–	–	..	–	–	–	–	..	–	–	+
	E.f.	–	–	+	..	+	–	–	+	..	–	–	–
Baker	E.c.c.	..	+++	..	+	+	+	+	+	–	+	+	++
	E.f.	..	–	..	–	–	–	–	–	+	++	–	–
	E.n.c.	..	–	..	–	–	–	–	+	–	–	–	–
Fursk	E.f.	..	+	+	+	–	+	+	–	..	–	–	++
	E.n.c.	..	–	–	–	–	–	–	–	..	++	+++	+++
	E.n.f.	..	–	–	–	–	–	–	–	..	+++	+++	+++
	Tet.c.	..	–	+++	–	–	+	–	–	..	+	–	–
	Tet.f.	..	+++	+	+++	+++	++	+	+	..	+	+++	–

Hare	L.c.	..	+++	+++	+++	+++	++	+	..	+	–	–	–
	E.n.c.	..	+	+	+	–	–	–	..	–	–	–	–
	E.n.f.	..	+	–	+	–	–	–	..	–	–	–	–
Jones	E.c.c.	..	..	++	++	+	–	–	–	–	–	–	–
	E.f.	..	..	–	–	–	+	–	–	–	–	–	–
	E.n.c.	..	..	+++	++	–	–	–	–	–	–	–	–
	E.n.f.	..	..	–	–	–	–	–	–	–	–	+	+
McLaggan ..	–	–	..	–	..	–	–	–	..	–	–	–	–
Green	E.c.c.	–	..	+	+	+	–	+	+	..	+	+	..
	E.n.f.	–	..	–	–	–	–	–	–	..	–	+++	..
	E.n.c.	++	..	+	++	+	++	+	+	..	+	+++	..
Bartholomew ..	E.c.c.	–	+	++	++	+	–	–	–	..	–	..	..
	E.f.	–	++	++	–	–	++	+++	–	..	–	..	..
Cooke	–	–	–	–	–	–	–	..	..	–	–	–	..
Downs	E.c.c.	..	+	..	++	++	+	+	–	+	–	–	..
	E.h.c.	..	–	..	–	–	++	+++	+++	+++	++	–	..
	E.f.	..	++	..	–	–	–	–	–	–	+++	+	..
Jenkins	E.n.c.	..	+++	+	..	++	++	+	..	+	+	++	+
	E.n.f.	..	–	–	..	–	++	–	..	–	–	–	–
Ball	E.h.c.	..	..	..	++	++	+	+	+	–	–	–	–
	E.f.	..	..	..	–	–	–	–	–	–	–	+	–
Ballance	E.c.c.	+	+	..	–	–	+	..	..	–	+	..	–
	E.n.c.	–	–	..	–	–	–	..	..	–	++	..	–
Cherldine	E.c.c.	+++	+	+	+	+	+	+	+	..	..	..	..
	E.f.	–	–	–	–	–	+	–	–	..	..	..	..
	E.n.f.	++	–	–	–	–	–	–	–	..	..	..	..
	Tet.c.	–	–	–	–	–	++	+++	+++	..	..	..	..
	Tet.f.	–	–	–	–	–	+++	–	–	..	..	..	..
Jackson	E.c.c.	–	–	–	–	+	+	+	..	..	..	–	..
	E.h.c.	–	–	–	–	–	–	+	..	..	..	–	..
Reader	E.c.c.	+	+	–	..	..	+	–	..	–	+	..	–
	E.f.	+	–	+	..	..	–	+	..	–	–	..	+
Briggs	–	..	–	–	–	–	–	–	..	..	–	..	–
Miller	E.h.c.	..	..	–	+	..	+	+	++	++	++	++	..
Carsom	E.c.c.	+	+	+	+	+	..	..	..	..	+	++	..
	E.f.	++	–	+	–	–	..	..	..	..	+	–	..
Watson, C. ..	E.f.	..	–	–	–	+	–	–	–	..	..	..	..
Watson, A. ..	E.n.c.	+	+	+	–	++	+	+	..	..	..	..	..
	E.n.f.	+	–	–	–	–	–	–	..	..	..	..	..
Hewitt	–	–	–	–	..	–	..	..	..	–	–	..	–
Cable	–	–	–	–	–	–	–	..	..	..	..	–	..

Table I.—*Continued.*

	A	1	2	3	4	5	6	7	8	9	10	11	12
		R.B.C.										R.B.C.	
Hollow	E.f.	+++	+	+	..	..	..	..	..	+++	++	+++	+++
	Trich.	+	+	–	..	..	..	..	..	++	–	–	–
Allen	E.c.c.	–	..	+	+	–	..	..	..	–	++	..	–
	E.f.	–	..	–	–	+	..	..	..	+	–	..	–
Parry	E.c.c.	–	..	..	..	..	+	..	–	–	–	–	–
	E.f.	++	..	..	..	..	–	..	+	+	–	–	–
	Tet.f.	–	..	..	..	..	–	..	–	–	–	+++	+++
Clarke	E.c.c.	+++	++	+	++	–	–	+	..	..	..	..	..
	E.f.	–	+	++	+++	+	+	+++	..	..	..	..	..
Williams	–	–	..	–	–	–	–	–	–	..	..	..	..
Draper	–	–	..	..	..	..	–	–	–	–	–	–	–
Kewley	E.c.c.	–	..	+	+	+	++	+	..	..	..	..	..
	E.h.c.	–	..	–	–	–	–	++	..	..	..	..	..
	E.f.	–	..	++	+	+	–	+	..	..	..	..	..
	L.c.	–	..	–	–	–	–	++	..	..	..	..	..
Bass	–	–	–	–	–	–	–	..	..	..	..	..	..
Bennett	–	–	–	–	–	–	–	..	..	..	..	..	..
Mullen	E.c.c.	–	..	+	+	+	+	–	..	..	..	..	..
	E.f.	–	..	–	–	–	–	–	..	..	..	..	..
	E.n.c.	–	..	++	+	+	+++	+	..	..	..	..	..
	E.n.f.	–	..	–	–	–	+	+++	..	..	..	..	..
Bond	E.c.c.	+++	++	..	–	+	–	..	..	..	..	..	..
	E.f.	–	–	..	–	+	–	..	..	..	..	..	..
	L.c.	+++	++	..	+++	+++	+++	..	..	..	..	..	..
	E.n.c.	+++	+	..	–	–	–	..	..	..	..	..	..
	E.n.f.	–	–	..	–	–	–	..	..	..	..	..	..
Sheather	E.c.c.	–	++	++	+	+	+	..	..	..	..	..	..
Haddack	E.c.c.	..	–	..	..	..	–	..	+	–	–	–	..
	L.c.	..	+	..	..	..	+++	..	+++	+++	+++	+++	..
	E.n.c.	..	–	..	..	..	–	..	++	++	++	++	..
	E.n.f.	..	–	..	..	..	–	..	++	++	–	–	..
McDonald ..	E.c.c.	..	–	..	–	–	..	–	..	–	+	..	..
	E.f.	..	–	..	–	–	..	+	..	–	–	..	..
	E.n c.	..	–	..	–	–	..	–	..	–	++	..	..
Robertson	E.c.c.	..	..	+	..	..	–	..	+	+	..	–	–
Carr	**E.h.c.**	..	..	..	+++	..	+++	+	+++	+++	+++	..	..
	E.f.	..	..	..	++	..	–	+	–	+++	++	..	..
	E.n.c.	..	..	..	++	..	+	–	–	+++	+++	..	..
	E.n.f.	..	..	..	–	..	–	–	–	–	–	..	..

Bacon	E.c.c	..	+	+	–	–	–	–	..	..	..	..	..
Robertshaw ..	E.c.c.	..	–	+	+	–	+	..	..	..	..	..	..
	E.f.	..	–	–	–	–	+	..	..	..	..	..	..
Duthie	–	–	..	–	–	–	..	..	..	..	..	..	..
Smith	E.c.c.	..	+ +	+ +	+ + +	+	..	..	..	..	..	..	..
	E.f.	..	+ +	+ +	–	–	..	..	..	..	..	..	..
	E.n.c.	..	+ + +	+ + +	+ + +	+ + +	..	..	..	..	..	..	..
Cole	E.n.c.	..	..	–	–	–	..	..	..	..	+ +	–	..
	E.n.f.	..	..	–	–	+ +	..	..	..	..	–	–	..
Jackson	E.c.c.	..	..	..	..	..	+ +	–	+	+	+	..	..
	E.f.	..	..	..	..	..	–	–	–	+	–	..	..
	E.n.c.	..	..	..	..	..	–	–	–	–	+	..	..
Harris	E.h.c.	–	..	–	..	–	..	..	..	+	..	..	..
	E.f.	–	..	+	..	–	..	..	..	–	..	..	..
Ellmore	–	–	..	..	..	–	–	..	–	..	..	..	..
Carter	E.h.c.	–	–	–	..	+ + +	..	..	..	..	..	..	..
	E.f.	+	+	–	..	–	..	..	..	..	..	..	..
Turner	E.h.c.	–	–	–	..	+ + +	..	..	..	..	..	..	..
	E.f.	+	+	–	..	–	..	..	..	..	..	..	..
McClay	E.c.c.	..	+ +	+ +	..	+	+	..	..	..	..	..	..
	E.n.c.	..	+ +	+ + +	..	–	+ + +	..	..	..	..	..	..
Coughlin	E.c.c.	..	..	+	–	–	..	..	..	+ +	..	..	..
	E.f.	..	..	–	+	–	..	..	..	–	..	..	..
King	E.f.	..	..	..	+	–	..	..	–	..	–	..	..
	E.n.c.	..	..	..	+ +	+	..	..	+	..	+ +	..	..
	E.n.f.	..	..	..	+ +	–	..	..	–	..	–	..	..
Halling	–	..	..	..	..	..	–	–	..	..	–	..	..
Hill	E.h.c.	..	..	..	..	–	..	..	..	..	+ +	+ +	..
	E.f.	..	..	..	..	+	..	..	..	..	–	–	..
Woan	E.n.c.	..	..	..	+	–	–	..	..	..	..	..	..
Evans	–	..	..	..	–	–	–	..	..	..	..	..	..
Wathnough ..	–	–	–	..	–	..	..	..	..	..	..	..	..
Melvin	E.f.	..	–	..	..	+	..	–	..	..	..	..	..
	Tet. f.	..	–	..	..	–	..	+ +	..	..	..	..	..
Hopkins	–	–	..	–	..	–	..	..	..	..	..	..	..

ABBREVIATIONS.

E.c.c. = *E. coli* cysts.
E.h.c. = *E. histolytica* cysts.
E.f. = Unencysted entamœbæ (either *E. coli* or *E. histolytica*).
E.n.c. = *E. nana* cysts.
E.n.f. = *E. nana* free.
L.c. = Lamblia cysts.
L.f. = Lamblia free.
Tet.c. = Tetramitus cysts.
Tet.f. = Tetramitus free.
Trich. = Trichomonas.
R.B.C. in E.f. line = entamœba with included red blood corpuscles.

lamblia is the cause of diarrhœa with mucus, it is present in enormous numbers and there is no chance of missing it on first examinations. It is only when it is not producing symptoms that it is likely to be overlooked. Similarly, if *E. histolytica* is giving trouble, the probability is that the amœbæ or its cysts will be found at once. These errors therefore in the single examinations do not appear, or appear to a much smaller extent in those cases where the organism looked for is the actual cause of trouble. The error is the greatest in the search for carriers, and it is a consolation to know that if any infection is missed it is unlikely to have been the cause of trouble to the individual himself at the particular time, though it must never be forgotten that the *E. histolytica* carrier is the constant source of infection for others.

It should be mentioned that the records in Table I are based on thorough and careful examinations. For example, the time spent on the daily examination of any one case was not less than ten minutes and in most instances at least two or three films were subjected to a close scrutiny.

Examination of Various Groups of Men for Protozoal Infections.

(*a*) *Healthy Troops.*—An examination of a large number (1,979) of healthy men on full duty was undertaken with the object of discovering the percentage of carriers of various protozoa, especially of *E. histolytica*. The samples for examination were collected in the manner described above. The following groups were examined :—

Metras camp, 1,013 men.

Mustapha Convalescent Depot, permanent staff, 312 men.

Cooks of Sidi Bishr camp, 279 men.

Cooks of Mustapha Convalescent Depot, 119 men.

Cooks of camps at Mazareta, Metras, Docka, Mex and Gabarri, 191 men.

Royal Army Medical Corps staff of Orwa-el-Waska section, 19th General Hospital, 65 men.

In the first table (Table II) the *E. histolytica* findings alone are set forth. The men in each group are divided into three classes according as to whether they had served in Gallipoli and Egypt, Salonica and Egypt, or in Egypt alone. The cases examined are arranged in two columns representing a previous history of dysentery or not. Each man was carefully questioned as to whether he had had dysentery, and though it is impossible to verify the men's statements or to draw a distinction between past bacillary

or amœbic infections, still it is possible to obtain some idea as to the influence a previous dysentery has on the incidence of carriers of *E. histolytica*. It will be seen, at any rate, that by far the greater number of carriers gave no history of dysentery whatever. Of the healthy men who had served in both Gallipoli and Egypt there were examined 246 who gave a history of previous dysentery and 1,137 who gave no such history. Amongst the former there were found to be 16 carriers of *E. histolytica*, giving a percentage of 6·5, while amongst the latter there were 52 carriers giving a percentage of 4·5. Of the men who had served in Egypt alone only 20 gave a history of previous dysentery and amongst them no carriers were found, but of 568 who gave no history of dysentery 26 were carriers yielding a percentage of 4·5, a result which is identical with that obtained from the similar group of men who had served both on the Peninsula and in Egypt. This fact would seem to indicate that the incidence of infection was not greater on the Peninsula than in Egypt. The men, however, who gave a history of dysentery yielded a higher percentage of carriers than those who had no such history.

TABLE II.—HEALTHY MEN EXAMINED IN ALEXANDRIA FOR CARRIERS OF *E. histolytica* ARRANGED WITH REFERENCE TO PREVIOUS HISTORY OF DYSENTERY, STATION AND SERVICE.

Camp	Where stationed	P.D.	Carriers	Per cent	N.P.D.	Carriers	Per cent	Total per cent
Metras (1,010) ..	Gallipoli and Egypt	164	4	2·4	846	37	4·3	4·0
Permanent Staff, Mustapha (312)	Gallipoli and Egypt	12	0	0	47	8	17·0	13·5
	Egypt only ..	5	0	0	248	10	4·0	3·9
Sidi Bishr Cooks (279)	Gallipoli and Egypt	51	8	15·7	103	12	11·6	13·0
	Egypt only ..	4	0	0	96	5	5·2	5·0
	Salonica and Egypt	3	0	0	22	2	9·0	8·0
Mustapha Cooks (119)	Gallipoli and Egypt	9	3	33·3	26	1	4·0	11·4
	Egypt only ..	0	0	0	84	6	7·1	7·1
Mazareta, Metras, Docks, Mex and Gabarri Cooks (191)	Gallipoli and Egypt	11	0	0	72	4	5·5	4·8
	Egypt only ..	2	0	0	106	2	1·8	1·8
R.A.M.C. Staff, 19th General Hospital (65)	Gallipoli and Egypt	9	1	11·1	13	0	0	4·5
	Egypt only ..	9	0	0	34	3	9·0	7·0

P.D. = Previous dysentery. N.P.D. = No previous dysentery.

The highest percentage for *E. histolytica* was found amongst cooks employed at Mustapha Convalescent Depot and at Sidi Bishr camp. The cooks of Sidi Bishr camp showed a higher percentage of protozoal infections than any other group of healthy men examined.

The total number of healthy men examined was 1,979 and the complete findings are shown in the last column of Table III. These may be taken as representative figures for the healthy troops in Alexandria, as the men were taken in groups from very different areas. It must not be forgotten that the figures are based on the result of a single examination.

TABLE III.—THE VARIOUS PROTOZOAL INFECTIONS FOUND AMONGST A SERIES OF 1,979 HEALTHY TROOPS EXAMINED IN ALEXANDRIA IN THE EARLY PART OF 1916.

	R.A.M.C. Staff, 19th General Hospital	Troops in Metras Camp	Permanent R.A.M.C. Staff, Mustapha Convalescent Camp	Cooks employed at Mustapha Convalescent Camp	Cooks at Mazareta, Metras, Docks, Gabarri and Mex Camps	Cooks at Sidi Bishr Camp	Total
Total examined	65	1,013	312	119	191	279	1,979
E. histolytica ..	6·1	4·0	5·7	8·4	3·1	9·6	5·3
E. coli	17·0	15·8	27·8	16·0	23·0	25·4	20·0
Entamœbæ (undiagnosed)	0	0·3	1·9	5·0	3·6	1·8	1·3
E. nana ..	0	0	0	1·6	0	0·7	0·5
Lamblia ..	0	4·3	5·4	6·0	7·8	4·6	4·8
Trichomonas ..	0	0·49	1·6	1·6	1·0	2·8	1·1
Tetramitus ..	0	0·39	0·6	5·0	2·6	2·1	1·1
I. cysts	4·3	2·0	3·5	2·5	2·0	6·4	3·0

The other protozoal findings in these various groups are set forth in the second table (Table III). It will be seen that the infections in the various groups agree fairly closely. As was to be expected, the commonest protozoon is *E. coli*. The second is *E. histolytica*, while lamblia comes next. Tetramitus and trichomonas occurred in equal frequency. Undiagnosed entamœbæ (unassociated with cysts and not including red blood corpuscles) are placed in a group apart. The iodine-cysts were fairly regularly encountered, as were the small amœbæ which we have called *Entamœba nana*.

(*b*) *Convalescents*.—It was thought that some insight into the various protozoal infections would be gained by examining convalescents from various diseases in the Convalescent Depot at Mustapha. Accordingly, we examined 328 convalescents, with

the results set out in the second column of Table IX. It will be seen that the percentages of infections did not differ to any extent, though they were generally higher than those we found amongst the healthy men, and, furthermore, they resembled very closely the findings made by one of us in London last year amongst 556 cases which had been invalided from Gallipoli and the Eastern Mediterranean (Table IX). It will be seen that the London cases gave slightly higher percentages all round. Another notable feature is the absence of any coccidial infections amongst the Egyptian cases. Apart from the difference in the coccidium infections, the variation in the two results can be explained by the fact that many of the London cases were examined more than once, and infections not found on first examinations were encountered at subsequent ones. From what has been said above regarding the fallacy attending the single examination, it is perhaps surprising that the results agree as closely as they do. The Mustapha cases were only examined once.

Of these convalescents 217 had served on the Peninsula, and of this number 58 gave a history of previous dysentery, while 157 had no such history. The percentage of *E. histolytica* carriers amongst the former was 12·0, whilst amongst the latter it was 7·8. There were 111 convalescents who had not been on the Peninsula, and they had all served in Egypt alone except 11 who had been at Salonica. Only 8 gave a previous history of dysentery, and no carriers were found amongst them, whilst the remaining 103 who had no history of dysentery yielded 4 carriers. These results are shown in Table IV below.

TABLE IV.—THE CARRIERS OF *E. histolytica* AMONGST A SERIES OF 328 CONVALESCENTS IN MUSTAPHA CONVALESCENT DEPOT, ALEXANDRIA, ARRANGED WITH REFERENCE TO STATIONS AND PAST DYSENTERY.

Where stationed	P. D.	Carriers	Per cent	N. P. D.	Carriers	Per cent	Total per cent
Gallipoli and Egypt ..	58	6	12·0	159	11	7·0	7·8
Egypt only, or Egypt and Salonica	8	0	0	103	4	4·0	4·0

(*c*) *Hospital Cases.*—Those included under this heading are cases which were admitted to the Orwa-el-Waska section of the 19th General Hospital for dysentery, diarrhœa, and other intestinal disorders. In practically all these cases the entire stool was examined, and the character of the stool noted. The great

majority of those described as blood and mucus were from cases of bacillary dysentery, while only a few (6·1 per cent) were from cases of amœbic dysentery. In Table V given below the findings in the 961 cases tabulated are arranged according as to whether the stool was formed, unformed, liquid, or blood and mucus. In the latter case it does not necessarily mean that the stool consisted of nothing but blood and mucus, but that blood and mucus was present. In the majority, however, as these were cases of bacillary dysentery, blood and mucus was alone present, or formed the bulk of the stool in the manner characteristic of this disease. The percentages in the four columns show clearly that protozoa were most common in the unformed or liquid stools. It is, perhaps, surprising that the encysted forms of *E. coli* and *E. histolytica* were more often found in stools of this kind than in the formed stool. As was to be expected, free forms of *E. histolytica* with included red blood corpuscles were only found in the case of the blood and mucus stools yet encysted; *E. histolytica* were found fairly frequently in this type of stool. (In an examination made subsequently to the tabulating of these results, an active entamœba with included red blood corpuscles was found in a stool which was unformed, and which contained no blood or mucus either macro- or microscopically. Similarly trichomonas was found on one or two occasions in bacillary dysentery stools consisting of nothing but blood and mucus examined after the table was completed.)

TABLE V.—THE RESULT OF THE EXAMINATION OF THE 961 HOSPITAL CASES ARRANGED ACCORDING TO THE CHARACTER OF THE STOOL (IN PERCENTAGES).

	Formed	Unformed	Liquid	Blood and mucus	Total
Total cases	140	393	263	165	961
E. histolytica cysts	3·0	3·3	1·1	0·6	2·2
E. histolytica free (R.B.C.)..	–	–	–	6·1	1·0
E. coli cysts	6·2	14·0	12·0	3·0	10·4
Entamœba (undiagnosed)	–	3·8	1·9	–	2·0
E. nana	0·7	5·0	5·0	0·6	3·0
Lamblia	2·8	10·0	6·0	3·0	6·0
Trichomonas	–	3·6	5·7	–	3·0
Tetramitus	–	3·6	3·0	3·0	2·8
I-cysts	–	0·2	0·4	0·6	0·3

If we compare these results obtained from hospital cases mostly admitted for intestinal disorder with the findings in healthy men and in convalescents (see Table IX below), the most striking feature is the low percentage of *E. histolytica* and *E. coli* infections, while

the flagellate infections are higher, especially in the case of the unformed and liquid stools. This does not necessarily mean that the flagellates are the cause of the unformed or liquid stools, though they may be in some cases. With trichomonas, and to a lesser extent with tetramitus, which has a recognizable encysted stage, there is a difficulty of recognition in the formed stool. It is almost certain that if the stools of the healthy men, which are mostly formed when examined, were rendered liquid by the administration of salines, then the percentage of recognized flagellate infections would be increased. This is borne out by the fact that in the case of the *E. histolytica* carriers which were brought into hospital for treatment, flagellate infections were only recognized in many cases after the patients had been treated with salines. An examination of the charts produced at the end of this paper, and giving the histories of these *E. histolytica* carrier cases, will show how frequently the flagellates appear as the stools become soft. All the cases referred to, it must be remembered, were carriers of *E. histolytica*, which were found during the course of routine examinations of healthy men.

As we have already remarked, the majority of the 165 cases showing blood and mucus were undoubtedly cases of bacillary dysentery. Definite amœbæ with included red blood corpuscles were found in only 6·1 per cent of these cases. The remaining 93·9 per cent of cases were probably of a bacillary nature making bacillary dysentery over sixteen times more frequent than amœbic dysentery. This was quite in agreement with the experience of other hospitals in Egypt during the period covered by this report. Bacillary dysentery was everywhere much more common than amœbic dysentery, which was a comparatively rare disease in spite of the fact that such large numbers of carriers of *E. histolytica* existed.

(*d*) *British Prisoners in the Military Prison, Gabarri.*—An examination was made of 168 prisoners in the military prison. The findings in this case are of interest, for it was noted that the majority of the men were suffering from some intestinal disorder—the stools of as many as 138 of the 168 men being abnormal in one way or another. A bacteriological examination made by Capt. Campbell, R.A.M.C., bacteriologist to the 19th General Hospital, of the stools of ten cases taken at random yielded definite dysentery bacilli (mannite fermenting) in three, and bacillus Morgan No. 1 in four. The protozoological findings which are shown below did not afford any explanation of the condition of

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the men. Many of the men were passing dysenteric stools, others had chronic diarrhœa, and others were passing abnormally loose motions.

The protozoa found are distributed very much as they are amongst the cases examined in hospital (Column 5, Table IX, below). The *E. histolytica* infections are lower, but the figure 1·8 should most certainly be increased at the expense of the 17·2 for the undiagnosed amœbæ. It is noteworthy that the flagellate infections amongst these men are almost identical with those found amongst the hospital patients. The *E. nana* infections were higher than in any other group examined. The percentage of cases infected with blastocystis is high (41·0), but it was only in this group that a special note of the occurrence of this organism was made.

Though the men in Gabarri Prison were supposed to be healthy men, the condition of their stools showed them to be otherwise, with the result that they were more in line with the cases admitted to hospital for dysentery, diarrhœa, or other intestinal trouble.

Amongst these men again, as with the hospital cases, the general looseness of the stools explains the higher percentage of flagellate infections.

It is, perhaps, worthy of note that a very large proportion of the prisoners showed in the stool a large spore-bearing bacillus. This was found in at least 30 per cent of the cases examined, and was frequently present in such numbers that the microscopic field was covered with the bright refractile spores. The bacillus was isolated, and Capt. Campbell, R.A.M.C., identified it as *Bacillus megatherium.* It was often present in large numbers in stools containing mucus, the mucus itself appearing to be a very favourable medium for its growth. When amœbæ were present, the spores of the bacillus were frequently ingested by them.

(*e*) *Healthy Natives.*—It was evident as a result of examinations made by one of us in England during the latter part of 1915, and by both of us in Egypt, that the British troops in the Mediterranean war area were becoming heavily infected with various intestinal protozoa. We have shown that this infection is probably largely due to the flies which readily take up these protozoa from human excrement and deposit them upon articles of food. It is evident that for such an infection to be possible a reservoir must exist, and the native seemed the most probable source of this infection.

In order to test this theory it is necessary to examine the natives of Egypt, and we were able to do this owing to the kindness

of Dr. Kirton, who gave us permission to examine a number of prisoners in Hadra Prison, Alexandria. We examined in all 524 prisoners, with the results set out in the table below (column 6, Table IX). As the helminthic infections were so common in these men we have thought it worth while to include them also (Table VI).

It will be noted that the *E. coli* and *E. histolytica* infections are high while the flagellate infections are low. The I-cyst infections are also high. As the results are all based on a single examination it is evident that the actual infections are really considerably higher than our figures indicate. Nevertheless, the percentages are high enough to justify the conclusion to be drawn. As many as 13·5 per cent of the men were infected with *E. histolytica* and 48·6 per cent with *E. coli*. The I-cyst infections were even a little higher than the *E. histolytica*. It is evident, therefore, that the number of healthy natives infected with *E. histolytica*, *E. coli* and I-cysts, is sufficient to account for the spread of these infections to British troops in and around Alexandria, especially when we remember the part played by flies in the transportation of these protozoa and the manner in which the natives deposit their fæces broadcast over the land.

We examined a certain though small number of actual human fæcal deposits collected from corners and open spaces in Alexandria and found, as was to be expected, that the percentages of infections were not lower than those obtained amongst the prisoners in Hadra Prison. It is evident, therefore, that the native carrier is the source of infection for *E. histolytica* and other intestinal protozoa. The scarcity of flagellates amongst these natives has already been mentioned, and it may be that in the case of the flagellates some other reservoir exists, possibly some animal associated with man. It is noteworthy that we have found both trichomonas and lamblia in cats in Alexandria, while these flagellates are known to occur in rats and mice. So far no proof has been obtained as to the identity of these with the parasites of the human intestine.

To return to the prisoners of Hadra Prison, it is interesting that very few indeed of these men had any sign of intestinal disorder. They had a uniform diet, and this had the effect of producing a curious uniformity and monotony in the character of the stool. In the case of only three of the men could the stool be described as abnormal, and in one of these, a soft unformed stool, tetramitus was found.

A classification of the prisoners examined was made according

to the length of time they had been in prison. It was found that the infections amongst those who had been in jail one week only or under this time were not lower than amongst those who had served longer periods. It was evident that the infections could not be the result of life in jail—in other words, that the infections were not jail infections. This is borne out also by the result of our examination of fæcal deposits taken at random about the town which has been referred to above.

TABLE VI.—Helminthic Infections amongst 524 Healthy Native Prisoners in the Hadra Prison, Alexandria.

	No.	Per cent		No.	Per cent
Trichocephalus ..	68	12·9	*Tænia saginata* ..	21	4·0
Ascaris	265	50·4	*Tænia solium* ..	3	0·57
Ankylostoma	55	10·5	Bilharzia	19	3·6
Oxyuris	5	0·98	*H. heterophyes* ..	2	0·38

(*f*) *Native Cooks.*—In addition to the examination of native prisoners in Hadra Prison, we examined a series of eighty-seven native cooks who were employed in an army bakery, and the Hotel Metropole, which was used as a restaurant by soldiers employed in Alexandria. The natives were of a better class than the native prisoners in Hadra Prison, and their infections conform more to the type found amongst the British troops. The amœbic infections were lower, and the flagellate infections higher than among the prisoners. The results of this examination are shown in column seven of Table IX below.

The helminthic infections were also lower than amongst the native prisoners.

TABLE VII.—Helminthic Infections amongst Eighty-seven Native Cooks in Alexandria.

	No.	Per cent
Ascaris	3	3·4
Ankylostoma	3	3·4
Trichocephalus	3	3·4
Strongyloides	1	1·1

(*g*) *British West Indian Troops.*—Only forty-eight of these natives of British West India were examined, and they were all employed as cooks at Mex Camp, where the British West Indian troops were stationed. The protozoal infections give figures which are considerably lower than those of the natives of Alexandria

examined in the Hadra Prison, and resemble more the results we obtained with the British troops (Column 7, Table IX below). The helminthic infections were, however, high, and we have added our findings in this direction. These results are shown in the following table :—

TABLE VIII.—HELMINTHIC INFECTIONS AMONGST FORTY-EIGHT BRITISH WEST INDIAN SOLDIERS IN ALEXANDRIA.

	No.	Per cent
Trichocephalus ..	15 ..	31·2
Ascaris	12 ..	25·0
Bilharzia (sc. h.) ..	1 ..	2·0
Ankylostoma	8 ..	16·0
Strongyloides	1 ..	2·0

TABLE IX (COMPOSITE TABLE).—PROTOZOA FOUND AMONGST CONVALESCENT AND HEALTHY TROOPS IN ALEXANDRIA AND LONDON AND NATIVES IN ALEXANDRIA. (PERCENTAGE OF INFECTIONS).

	Healthy troops	Con-valescents Alexan-dria	Con-valescents London	Hospital cases	Gabarri Prison	Hadra Prison. Natives	Native cooks	British West Indian cooks
Total examined ..	1,979	328	556	961	168	524	87	48
E. histolytica ..	5·3	6·4	10·8	3·2	1·8	13·7	11·5	4·1
E. coli	20·0	31·7	39·0	10·4	12·0	48·6	20·7	18·7
Lamblia	4·8	5·4	16·0	6·0	6·0	0·57	7·0	4·1
Trichomonas ..	1·1	0·67	1·6	3·0	2·4	0	1·1	0
Tetramitus	1·1	0·9	0·7	2·8	3·2	0·19	1·1	0
Coccidium isospora ..	0	0	2·7	0	0	0	0	0
Coccidium eimeria ..	0	0	0·2	0	0	0	0	0
Entamœbæ (undiag-nosed)	1·3	1·8	0	2·0	17·2	0·57	1·1	0
Iodine cysts	3·0	2·0	5·2	0·3	0	14·8	7·0	4·1
E. nana	0	0	1·0	3·0	12·0	0	0	0

In the case of the London convalescents who were examined in London by one of us (C. M. W.) during the latter part of 1915, the small amœba now entered as *E. nana* was in the original report entered as *Amœba limax*. As will be explained below this diagnosis was most probably erroneous. Coccidium (isospora) was found once, and the flagellates *Tricercomonas intestinalis* and *Waskia intestinalis* several times in Alexandria, but as they were not found at the first examination of the cases, they are not included in the table.

General Remarks on the Protozoal Infections.

The results of the examinations of the various groups described above are set out in tabular form in Table IX.

(1) *Entamœba coli.*—It will be seen at once that *E. coli* is by

far the commonest protozoon of the human intestine in Egypt as in all other countries where it has been sought. Amongst the British troops it was found most commonly in the case of the convalescents, 31·7 per cent of those examined showing this parasite. The convalescents from the Eastern Mediterranean examined in London during the latter half of the year 1915 showed a similar high percentage of *E. coli* infections. It is difficult to explain why the convalescents (mostly from dysentery or other intestinal disorders) should show a higher percentage than healthy men of a non-pathogenic amœba like *E. coli.* It is possible that a damaged intestine is more liable to become infected with this protozoon, though why this should be so it is difficult to imagine.

The high percentage of *E. coli* infections amongst the natives of Alexandria has already been referred to above. It is interesting to note that the forty-eight British West Indians examined show a lower percentage of infections than any other group of healthy men examined. The low figure in the hospital cases and the men in Gabarri Prison, who were mostly suffering from some intestinal disorder, is to be explained by the soft or liquid character of the stool, as has been noted above. If a series of diarrhœic cases are examined it can be stated as a rule that the figures for the amœbæ will be below the average for healthy men, while those for the flagellates will be above.

(2) *Entamœba nana.*—The small amœba which we have called *E. nana* was found to be a common parasite in Egypt. It was some time before we were able to identify the cyst of this amœba, for in the first two or three months we were accustomed to regard it as of a vegetable nature. It was for this reason that the amœba was not noted in any of the natives in Hadra Prison in the 197 healthy men, nor in the 328 convalescents. The amœba was certainly present but was neglected by us when in the encysted state, or was regarded as a small form of *E. coli* or *Amœba limax* when free. In the other groups examined subsequently it was constantly present, and attained its highest percentage in the case of the men in Gabarri Prison. As will be explained below, the small amœba identified as *A. limax* in the case of the London convalescents, was in all probability *E. nana.*

(3) *Coccidium* (*Isospora*).—Infection with this coccidium was only met with once in the case of an *E. histolytica* carrier who was being controlled in hospital. The oöcysts were first noted about a week after the beginning of the observation. It is remarkable that

fifteen cases of this infection were met with in London out of 556 cases examined, while in Egypt only one was seen out of a much larger number of examinations. It seems that coccidium infections were fairly common in Egypt during the latter part of 1915 when they were being found in England, and this may be explained by the fact that the men in both places had then come recently from Gallipoli where the infection may have been acquired. The scarcity during the first six months of 1916 in Egypt may be due to the fact that the infection had in most cases died out. There may, however, be some seasonal incidence of the infection. As the figures in the tables are based on the single examination the one case of coccidiosis does not appear, as it was only found at a later examination.

(4) *Entamœba histolytica*.—One of the main objects of the investigation we undertook in Alexandria was the determination of the percentage of carriers of *E. histolytica* amongst healthy troops. From what has already been stated and the figures shown in Table IX, it will be seen that there is a high percentage (5·3) of carriers amongst the healthy British troops in Egypt. The figure would be higher if allowance were made for the error of the single examination on which the figure 5·3 is based. The carriers were no more numerous amongst men who had served in Gallipoli, as we have already shown above. This fact would seem to indicate that Gallipoli was not more heavily infected with *E. histolytica* than Egypt, which has been known to be an endemic centre for amœbic dysentery for upwards of forty years.

The convalescents examined in London and Alexandria showed a higher percentage of carriers than the healthy men, while the hospital cases, on account of their frequently liquid stools with their flushing properties, gave a much lower figure. It should be remarked here that many of the hospital cases which gave a negative result when the stool was liquid gave a positive result later when the stools became formed. As the figures are those resulting from the single examination, the findings of subsequent examinations were not included.

The presence of such a large number of carriers amongst healthy men was not suspected, and came as a somewhat startling revelation. The percentage was highest amongst the British troops in the case of cooks employed at Mustapha and Sidi Bishr camps. It is difficult to explain why this should be so unless the flies which swarm about the cook-houses are sufficient to account for it. The origin of all these infections is undoubtedly the native, as shown by

the high figure obtained in the case of the prisoners in Hadra Prison.

The carrier problem of *E. histolytica* raises many important questions which will be dealt with below.

(*a*) *The Possibility of examining Healthy Troops, with a View to the Isolation of Carriers.*

Provided there were means at our disposal for the separation of all carriers, and that the examination did not involve any great delay, it would undoubtedly be advisable to separate and treat with emetin all carriers of *E. histolytica.* At the present time, however, such a course is absolutely out of the question, for we not only have no means for undertaking examinations on such a scale—examinations which are often difficult even for a practised observer—but it would be quite unjustifiable to detain such a large number of healthy men for the time required for examination and treatment. Even supposing that all the carriers amongst the troops were separated and treated in a country like Egypt, we are no better off, for the source of infection is always present in the shape of the native and the fly, with their insanitary habits. In the Alexandria district the course was adopted of examining all the cooks employed. This involved a great amount of laborious work which was admittedly incomplete, as only a single examination was made. Still, this was a distinct advantage, as all the carriers which were thus identified were separated, and most of them were cured by emetin treatment. There was nothing, however, to prevent the men re-infecting themselves, and in order permanently to keep down the number of carriers amongst any group of men, it would be necessary to examine them regularly at stated intervals. It seems, therefore, that in a country like Egypt very little can be done in the way of isolating carriers of *E. histolytica* from amongst healthy troops, and one could not possibly advise that it should be undertaken on a large scale in time of war.

(*b*) *The Danger of Amœbic Dysentery spreading in England.*

Another aspect of the question is the possibility of the spread of amœbic dysentery to countries in which the disease does not already exist, and it has been suggested that troops which are to be moved from an area where the disease is endemic should be examined and the carriers detained. Here again the amount of work which would be necessary to carry out such a project shows this to be quite impossible in time of war except in the case of

small drafts. But in a country like England is there any real danger that the disease will be spread in this manner? Cases of amœbic dysentery contracted in England are not unknown, though they are far from common. It seems very improbable that the disease will establish itself there, for though it is only recently that the carrier problem of amœbic dysentery has attracted attention, it must not be forgotten that carriers have been constantly entering England before the present War, and that troops have often returned from countries in which the disease is endemic. There have undoubtedly been large numbers of carriers amongst such men, though no one has considered it worth while to examine them from this point of view. There must have been in the past every possibility that the disease would establish itself in England if the conditions favourable for the survival of cysts outside the body and their transference to other individuals had existed. Though isolated cases of infection have occurred, the disease has been exceedingly rare. This failure of the disease to establish itself must be the result of many factors, the most important of which are undoubtedly the existence of a good sanitary system and the comparative absence of flies, while climatic conditions undoubtedly play a prominent part. In England, even in rural districts, where the sanitary arrangements are often far from perfect, the infected material is not spread broadcast over the land as it is in countries like Egypt; while flies, though very numerous in certain localities, are never so universal as they are in warm countries, which are the natural homes of the disease.

With the establishment of large camps in rural districts of England, we may expect some temporary increase in the local cases of amœbic dysentery, but the disease is unlikely to gain a permanent footing in the country, for the British carrier will never in the long run aid the spread of the disease as does the insanitary native of Egypt.

(*c*) *The Advisability of examining all Convalescents with a View to the Isolation of Carriers of E. histolytica?*

With such a high percentage of *E. histolytica* carriers amongst healthy men in Egypt, it is evident that at least the same percentage of carriers will be found amongst convalescents. This has actually been the case amongst men who have been invalided not only for various intestinal diseases, but for quite other conditions. Men convalescing from many different diseases are constantly being invalided from Egypt, Mesopotamia, and other areas in which

amœbic dysentery is endemic. The great majority of these men when they reach England have recovered from their illnesses, and many of them are able to return to duty. A certain number, however, are still ill. In the case of those men who have recovered, it would seem quite unnecessary to institute examinations with a view to isolating the carriers of *E. histolytica*. These men are in the position of the healthy troops who are still on full duty, and amongst them the carriers are almost, if not quite, as numerous. If these men are clinically fit to return to duty, there does not seem any just reason for detaining them longer, for they will in no way increase the percentage of carriers amongst the healthy troops who have been removed from areas in which amœbic dysentery is endemic. In our opinion there is at the present time no justification for detaining a man just because he has been accidentally found to be a carrier of *E. histolytica* in the course of routine examination, even though he was invalided for dysentery in the first place.

With men however who are ill, whether their condition leads one to suspect that *E. histolytica* is or is not the cause of their illness, the question is a different one. Such cases can be suitably treated with emetin if *E. histolytica* is present. In these cases there would be no unnecessary detaining of healthy men.

It seems to us therefore that in dealing with convalescents at the present time from the point of view of *E. histolytica* infections the test should be a clinical one. If the men are clinically fit they should be discharged to duty, whereas if they are not fit an *E. histolytica* infection should always be looked for and treated, for it may be the cause of trouble, and involves no unnecessary detention of men who would be otherwise returning to duty. It is not of vital importance at the present time that all convalescents any more than all healthy troops should be examined for *E. histolytica* infections. The quick return to duty is far more important. Examination is only necessary in the case of men who are still ill and unable to return to duty. A man should be regarded as clinically fit if he shows no sign of the disease from which he suffered, is able to take full diet and undertake light duty and at the same time passes a normal stool, that is to say a stool which is macroscopically normal. It seems to us quite unnecessary and a waste of time to examine the healthy stools of such men with the object of detecting *E. histolytica* or other protozoal infections, for the finding of *E. histolytica* cysts in these men does not mean that they have had or are soon likely to have amœbic dysentery any more than the healthy men who have not been invalided. Further,

although we fully recognize that the convalescent cyst carrier may be a source of danger to others, the same is true of the much larger number of healthy and unsuspected cyst carriers whom it is of course quite impossible to detect, far less examine.

(d) The Length of Control Necessary after Treatment.

As there cannot be any question at the present time of eliminating all the *E. histolytica* carriers from amongst the troops it is unnecessary to control any healthy carriers which have accidentally come to light, after the completion of a course of treatment. As will be shown in the section devoted to the treatment of healthy carriers, it is possible to cure the infection in practically every instance by the combined subcutaneous and oral administration of emetin. *This refers only* to the *healthy* carriers, the great majority of whom have no history of dysentery. When a history of dysentery has been obtained it is in most instances impossible to decide whether it was bacillary or amœbic There are however unhealthy carriers. These are cases which suffer from chronic amœbic dysentery. They have repeated attacks when blood and mucus appear in the stool along with active amœbæ with included red blood corpuscles. Alternating with these are periods when dysentery is not evident and the stools may or may not be normal, though generally they are soft and mucoid. Microscopic examination at this time reveals the same condition (cysts and free amæbæ) as in the healthy carrier. These chronic amœbic dysenterics are most difficult to cure and, as will be shown below, the majority relapse sooner or later. Such cases are quite incapable of going back to duty and they have to be watched carefully for some weeks after any course of emetin treatment, for the latter is very misleading in giving a sense of false security, as in nearly every case it brings about a *temporary* cure.

In dealing with convalescents from dysentery or other intestinal disorders in war time we would therefore suggest the following rules.

(1) If the case has clinically recovered and is able to take full diet and perform light duty and passes a normal stool, it is not necessary to submit the stools to microscopic examination for the detection of *E. histolytica* or other protozoa. Such cases if examined would yield a certain number of *E. histolytica* carriers, but these would be hardly more numerous than the carriers amongst a group of healthy men who had not been invalided. These men can return to full duty.

(2) If the case has not recovered, being still ill or passing abnormal stools, microscopic examination should be carried out and any *E. histolytica* infection treated, as this may be the cause of the trouble.

(3) Supposing, however, it is decided to isolate and treat all the carriers amongst the dysentery convalescents, this is not to say that it is necessary to control the healthy carriers after treatment. In nearly every instance the treatment as explained below will lead to a permanent cure, and it is only a waste of time to detain for purposes of control men who were not suffering from their infection even when it was present. In the case of men who have suffered from repeated attacks of amœbic dysentery and are chronic amœbic dysenterics a careful control of at least one month after treatment is complete is indicated. As will be shown below the treatment of such cases is very unsatisfactory.

(4) *Flagellate Infections.*—As regards the flagellate infections the most noticeable feature is the fact that the highest percentages found were amongst the hospital cases and the men in Gabarri Prison. As we have already explained, these two groups resembled one another as regards the characters of the stools. It might be urged that this is an argument in favour of the pathogenicity of the flagellates, but it seems more probable that the flagellates have become evident because the stools are liquid or soft. Evidence in this direction is to be obtained from the *E. histolytica* carrier cases which were taken into hospital for treatment and were examined every day. These men were to all intents and purposes healthy men passing normal stools. During the course of treatment, on account of the administration of salines or emetin, the stools became liquid or unformed, and with this change flagellate infections which had not been evident in the formed stools often made their appearance. It will be noted that in the tables the two flagellates, Tricercomonas and Waskia, which are described below, do not appear. This is due to the fact that though they were found in carriers of *E. histolytica* it was not at the first examinations when the stools were normal but only later in the observation when the stools had become soft. It seems quite clear that the percentage of flagellate finds in a group of healthy men would be considerably increased if the stools were first rendered liquid or soft by the administration of salines for a few days.

The Question of invaliding for Flagellate Infections.

At the present time, there are being admitted to the hospitals in many of the war areas cases of intestinal disorder which are

associated with flagellate infections of the intestine. Many of these cases are finding their way to England and others are being discovered there, and it becomes a matter of importance to decide whether such infections are to be regarded in themselves as a sufficient cause for the invaliding of a man. Microscopic examination of the stool for protozoal infections has never been undertaken before to the extent it has reached in the present War. Formerly this branch of examination was completely neglected and it is only during the last year or so that the subject has attained any importance. But very few, even of those who have taken an interest in tropical diseases and have been accustomed to teach this branch of medicine, have had any previous knowledge of the subject apart from the fact that amœbæ produce a form of dysentery and that the flagellates may be found in diarrhœic conditions. Since the commencement of the War, however, the interest in the intestinal protozoa of man has extended very much, and many microscopists have taken up the study of these protozoa and are able now to differentiate between the various intestinal amœbæ and flagellates of man.

We think there is a danger that undue importance will be attached to the mere presence of protozoa in the intestine. It is an undoubted fact that from the point of view of efficiency the vast majority of men showing protozoal infections are quite normal and capable of undertaking their regular duties. This is true even of the majority of carriers of *E. histolytica*, a protozal organism which may lead to most serious consequences.

It seems to us that the mere fact that a man is found, in the course of routine examination, to be infected with lamblia, trichomonas or tetramitus, is no justification for certifying him as a carrier who must be isolated and treated. We recognize that a certain small percentage of men showing these infections are ill, but quite apart from the possibility of the flagellates being the cause or the only cause of the malady from which they suffer, these men must be invalided on clinical grounds, and treatment may then be directed against their flagellate infections if these are thought to be the cause of the trouble. The test therefore, in our opinion, of every case of flagellate infection must be a clinical one, and so soon as any man's symptoms clear up, even though the flagellates lamblia, trichomonas and tetramitus are still present, or are known to have only temporarily disappeared from the stool, the man should be discharged to duty. Unless this rule is followed very soon, the hospitals and convalescent camps will become filled with men who are quite capable of performing their duties as good soldiers.

It does not seem to be thoroughly realized that as there is a normal bacterial flora of the human intestine so there may be a normal protozoal fauna. Just as the majority of the intestinal bacteria never cause any trouble whatever, so most of the intestinal protozoa live in the gut without doing any harm and without producing any symptoms. If this fact was properly understood there would be less risk of every protozoal infection being regarded as a source of danger.

The Dysentery of the Eastern Mediterranean in 1915.

It is now universally known that dysentery was the cause of invaliding of large numbers of our soldiers from the Peninsula in 1915 and the impression gained ground that, at any rate during the first few months of the campaign, the dysentery was mostly of the amœbic type. It will be admitted that the epidemic was quite unexpected, and at first arrangements for adequate diagnosis of the cases did not exist, so that all the errors which will be discussed in this paper must inevitably have crept in. In the majority of cases, those who had to do with the diagnosis had very little or no previous experience of the intestinal protozoa of man, and were unconscious of the difficulties to be encountered in distinguishing between pathogenic and non-pathogenic entamœbæ, or even between entamœbæ and some of the large macrophages and other cells encountered in bacillary dysentery infections. It seems certain, therefore, that the prevalence of amœbic dysentery must have been considerably exaggerated.

That amœbic dysentery did actually occur is an undoubted fact, for Captain Archibald, who had had considerable previous experience of the disease, met with it fairly commonly in his laboratory at Mudros. Further, many of the cases were clinically of the amœbic rather than the bacillary type, as Captain Campbell who was working at Cape Hellas informs us. Evidence in another direction is obtained from the results of one of us (C. M. W.) who examined in London a large number of cases invalided from the Peninsula in the latter part of 1915. Amongst these cases there was a percentage of over ten of carriers of *E. histolytica* and protozoal infections were generally high. These men had mostly come direct from Gallipoli, so that *E. histolytica* infections must have been common on the Peninsula. Captains Archibald and Hadfield, working at Mudros East, state (JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, June, 1916) that of 518 dysenteric stools examined

362, or seventy per cent, were due to amœbic infections. The authors in explaining their method of diagnosis state that entamœbæ containing phagocyted erythrocytes were regarded as pathogenic, a view with which we entirely agree, but they do not assert that all their cases were diagnosed on this basis, nor do they tell us in what proportion of their cases the non-pathogenic *E. coli* was found. Furthermore they state that the evidence was obtained by the direct examination of the amœbæ or their cysts. Now it would be interesting to know what was the number of cases diagnosed by the occurrence of cysts in the stool. As will be explained below, the presence of the cysts of *E. histolytica* in the stool, though it proves infection with this amœba, does not necessarily mean that the case is or has been one of actual amœbic dysentery. Other forms of dysentery occur in cases which are carriers of *E. histolytica*, and in such there is produced a dysenteric stool in which cysts of *E. histolytica* may be found. The section of the above report by Captain Campbell on the work done at Cape Hellas shows that sixty-five per cent of the stools with blood and mucus contained amœbæ, but he says definitely that phagocytosis of red blood corpuscles was noted at times. It is evident therefore that in many cases the amœbæ found by him must have been *E. coli*, which, judging by the results obtained in London, were more than three times as common as *E. histolytica* in men on the Peninsula.

In other laboratories in the Eastern Mediterranean, cases of amœbic dysentery were met with, but none of these with whom we have discussed the subject are willing to admit that amœbic dysentery was present to the extent that has been made out. Captain Campbell tells us that the conditions were not necessarily the same all over the Gallipoli war area. He suggested that foci of amœbic infection might exist and that in this manner discordant results would be obtained.

The results obtained by Ledingham, Penfold and Woodcock, at King George's Hospital in London (*British Medical Journal*, November 13, 1915), throw some light on this question. Cases returning from Gallipoli were examined both bacteriologically and protozoologically. In one series representing cases which had left the Peninsula, in June, July and August, dysenteric stools occurred in fifteen cases and dysentery bacilli (chiefly Shiga) were recovered from all of these, while *E. histolytica* occurred in none. This result is difficult to explain if it is assumed that amœbic dysentery was more prevalent than bacillary during the first months of the campaign. In a later series of cases these observers

found by the agglutination test that 47·5 per cent gave evidence of past bacillary dysentery, while none were amœbic. Even allowing for a possible reduction of amœbic infection by emetin, it would seem that bacillary dysentery was more common on the Peninsula during the early months of 1915 than has been supposed.

The general character of the outbreak on the Peninsula in its epidemic form is so contrary to what we know of amœbic dysentery that one hesitates to ascribe the bulk of the dysentery to the *E. histolytica.* It seems more probable that many factors were at work, some of them not yet identified. We feel therefore that there is a tendency to over-estimate the amount of amœbic dysentery on the Peninsula during the summer months of 1915, though we recognize that this disease undoubtedly was an important factor in the invaliding of our troops from this section of the Mediterranean area.

Summary of Matter discussed in Part I.

(1) The collection of samples of stools from healthy men in camps for purposes of bacteriological and protozoological examination can be successfully carried out, provided a definite system is established. Such a method, which yielded all that was required, is described in the text.

(2) The examination of a single sample from any individual for intestinal protozoa gives a result which is far from reliable. In a series of cases examined with a view to the discovery of the error, the number of *E. histolytica* infections resulting from repeated examinations were three times as great as the result obtained at the first examination. If, however, the protozoal organism is the actual cause of any intestinal trouble at the time of examination it is usually present in large numbers and is rarely missed on the first examination.

(3) Amongst 1,979 healthy men in camps 106 were found to be carriers of *E. histolytica*, giving a percentage of 5·3. Of these, 1,383 had served on the Peninsula as well as in Egypt, and of them 246 gave a history of previous dysentery, giving a percentage of carriers of 6·5, while 1,137 gave no such a history and there was only a percentage of carriers of 4·5. Of 568 men who had served only in Egypt, and who gave no history of previous dysentery the percentage of carriers was the same, namely, 4·5.

(4) Amongst the 1,979 healthy British troops examined in Alexandria, the percentage of protozoal infections generally was lower than amongst convalescents from dysentery and other intestinal troubles examined in Alexandria and London.

(5) The commonest protozoan found in healthy British troops in Egypt was *E. coli* (20 per cent), *E. histolytica* came next (5·3 per cent), and then *Lamblia intestinalis* (4·8 per cent). *Trichomonas intestinalis* and *Tetramitus mesnili* were found with equal frequency (1·1 per cent). *E. nana*, a new entamœba, was fairly common (0·5 per cent), while iodine cysts occurred frequently (3·0). These figures are all subject to the error involved in the single examination method.

(6) An examination of 328 convalescents from various diseases (chiefly dysentery or other intestinal disorder) in the Mustapha Convalescent Depot gave percentages of infections very similar to those obtained in the examination of a similar series of cases in England in 1915. The percentages were generally higher than amongst the healthy troops.

(7) An examination of 961 cases admitted to the Orwa-el-Waska Section of the 19th General Hospital between January and July, 1916, showed a lower percentage of *E. histolytica* and *E. coli* infections than amongst the healthy and convalescent men in camps. The flagellate infections (lamblia, trichomonas and tetramitus), however, were higher. This is explicable on the ground that many of the cases were suffering or had just suffered from diarrhœa, a condition which tends to get rid of amœbic infections (temporarily) but tends to reveal a flagellate infection which is not easily detected in the formed stool.

(8) An examination of 524 healthy natives in Hadra Prison, Alexandria, showed a high percentage of infection with *E. histolytica* (13·5), *E. coli* (48·6) and cysts (14·8). The flagellate infections were low. In only three of the 524 cases could the stool be described as abnormal. Similar results were obtained in the examination of human fæcal deposits collected in and around Alexandria.

(9) It is evident that the native of Egypt is acting as a reservoir of infection for the intestinal protozoa with which the British troops have become and are becoming infected.

(10) Lamblia and trichomonas have been found to occur in Alexandria cats. These animals, with rats and mice, may act as reservoirs of infection.

(11) The introduction of carriers of *E. histolytica* into England at the present time as a result of the movements of troops is unlikely even under existing conditions to be followed by severe outbreaks of amœbic dysentery. In the past carriers have been

constantly returning to England without any severe outbreaks resulting.

(12) It is impracticable to examine large bodies of healthy troops with a view to eliminating the carriers of *E. histolytica.* The majority of the carriers are perfectly healthy and we know nothing of the percentage of these carriers which actually pass on to a condition of amœbic dysentery. Nor do we know to what extent a carrier is likely to hand on his infection to another. It is clear that there are many healthy carriers of *E. histolytica* for every one who actually gets amœbic dysentery.

(13) In the case of men invalided for intestinal disorders and are still ill, if *E. histolytica* is found to be present, the condition can be treated, and if clinical recovery takes place this can be followed by discharge to duty. When every able-bodied man is needed for service in time of war it is not reasonable to detain any one just because he happens to be a carrier of *E. histolytica.* The number of undetected carriers amongst the healthy troops is far greater at the present time than amongst those invalided for one cause or another. It is unnecessary to examine all recovered dysentery convalescents with a view to detecting the carriers of *E. histolytica* or other protozoa.

(14) If, however, it be decided to identify by microscopic examination and to treat every healthy *E. histolytica* carrier amongst any group of convalescents or healthy men it is well to remember that after treatment it is unnecessary to keep all the cases under microscopic control in order to see if relapse will occur, for the results we have obtained show that the carrier is almost certainly cured by a proper course of emetin unless there has been a history of repeated attacks of dysentery.

(15) Similarly men with flagellate infections unless clinically ill should not be invalided from service.

(16) As a result of inquiries we have made and the examination of men who had returned from Gallipoli it appears to us that amœbic dysentery was not as common on the Peninsula during the summer months of 1915 as has sometimes been supposed.

(*To be continued.*)

TREATMENT OF GUNSHOT WOUNDS INVOLVING THE KNEE-JOINT.

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Much has been written with regard to the treatment of wounds of joints from the experience of surgeons at base hospitals. But the circumstances are so different in regard to the nature and treatment of wounds arising from the D—— Campaign that a short account of the conclusions arrived at from a very large experience of wounded is felt, not without justification, to be necessary. Though the French experience is very helpful yet there are such essential differences in the condition of wounds arising in G—— that, in many respects, different methods of treatment have been evolved.

These methods prove to be far more valuable to surgeons than those obtained from a blind compliance with the suggestions of surgeons operating in a different climate, on wounds infected with a different and in many ways a special virus. Above all, these wounded soldiers present different surgical conditions, arriving as they do for treatment at base hospitals after a much longer lapse of time from the time of the infliction of the wound than is the case in France. These cases have been treated partly by regimental surgeons, partly in clearing stations or stationary hospitals, and finally on board hospital ships for seven to twelve days before the base hospital is reached. There is an essential difference in the infected nature of the soil and in the coincident infections of a medical nature, such as dysentery. Again, the strain of war and absence of comforts of life and the prevalence of dysentery in the trenches has produced an extreme degree of exhaustion and loss of resistance to infective conditions in general.

This paper is based on a series of thirty-seven cases of injuries to the knee-joint caused by rifle-bullet, shrapnel ball and fragments of shell casing and bombs.

This series is but a small part of the total number of cases treated at hospital. From June to August, 1915, the stream of wounded was so incessant that careful note-taking was impossible.

Four different types of injury to the knee-joint are recognized.

(1) *Penetrating wounds* of the knee-joints or the suprapatellar pouch without comminution of the femur, tibia or patella; these are the cases in which there is no projectile or portion of projectile

lodged in the joint. The typical instance of this is a clean perforating wound caused by a rifle bullet which may perforate any one of the bones which form the joint. The perforation is clean and there is no comminution.

(2) *Traumatic arthritis* of the joint with effusion of blood or synovia into the joint caused by injury to the femur or by wound of the muscles of the thigh above the knee. All fractures of the lower third of the femur are accompanied by effusion into the joint. When the height to which the synovial reflection rises above the patella is considered, it is very frequently difficult to determine if the effusion in the joint is due to injury of the suprapatellar pouches by trauma or by direct communication with the septic condition of the compound fracture of the femur. The synovial pouches may be opened by the projectile that fractures the femur, but subsequently the synovial sac may be shut off from the septic condition around the fracture. This illustrates the need of very careful exploration during operations for ensuring thorough and dependent drainage of the compound fracture. Aspiration of the effusion and bacteriological examination settles this point. A comparatively accurate estimation of the condition of the joint may be obtained from the colour of the effusion in the cases where the necessary bacteriological tests by slide and cultivation would consume more time than the condition of the knee will allow. Clean glairy effusions are never infected, cloudy effusions practically always.

It is a matter of extreme difficulty without aspiration to determine if the joint is infected in those cases of compound fracture of the lower third of the shaft of the femur when there is much induration, redness and œdema in the neighbourhood of the joint; local extra-articular abscesses from pus tracking up the muscular planes of the thigh also add to the difficulties of diagnosis.

(3) This, the third type of knee-joint injury, is where there is a perforating wound of the joint with lodgment of bullet or shrapnel ball, or fragment of shell casing in the joint or in the articular ends of the bones.

The joint in this case may be locked in flexion from the impaction of a rifle bullet behind the crucial ligaments.

(4) The fourth type of variety is where there is a wound opening into the knee-joint with much comminution of the bones. The comminution may be so extreme as to cause dislocation of the joint. Among these can be included the cases of T-shaped fracture of the femur. These cases are by far the most serious from the almost inevitable supervention of osteomyelitis of the femur or

tibia when the cancellous tissue or the medullary cavities are opened to infection. Injuries to the condyles of the femur seem to be attended with far greater risk of disorganization of the joint than injuries to the tibia or patella; there is a better chance of the posterior condylar pouches of synovial membrane and the infra-patellar pouches being shut off from the general infection in the cases of comminution of the head of the tibia. Two cases of this kind where the anterior portion of the articular surface of the tibia had been extensively comminuted, yet the infection was so shut off from the rest of the joint that the posterior part of the articulation and the synovial pouches remained uninfected. The condition here obtained by injury resembles the Stephen Smith amputation where the leg is removed at the articulation without opening the synovial cavity of the joint. After aspiration of the suprapatellar pouches the two cases made uninterrupted recoveries.

It is important to recognize that, for the purpose of treatment and essential recognition of acute arthritis, the knee-joint can be divided into four cavities, each of which can be shut off by adhesions from the other. This bears out the importance of the most careful manipulation of the joint lest the adhesions should be broken down.

The four compartments of the knee-joint which I have seen infected without involvement of the rest of the joint are:—

(1) The articulation proper.

(2) The suprapatellar synovial pouches.

(3) The posterior condyloid synovial pouches.

(4) The bursæ in connexion with the joint, more particularly the semimembranosus bursa. These are usually in connexion with the post-condyloid pouches but may be shut off. These pouches in particular are of extreme importance, for the infective condition may clear up in the joint and yet remain in the bursal cul-de-sac. Collection of pus in the semimembranosus bursa often tracks down the inner side of the leg among the calf muscles. An abscess in the calf due to extension from the semimembranosus or popliteus bursa is a very common feature in the convalescence of cases of acute arthritis of the knee-joint. Such swelling and œdema of the leg may be caused as to suggest thrombosis of the popliteal vein and lead to a possibility of amputation for that supposed condition. Nor are these abscesses always easy to find.

The diagnosis of acute septic arthritis of the knee-joint is settled in the majority of cases by aspiration of the joint: clinical examination alone is insufficient in view of the presence of simple

traumatic arthritis of the joint in injuries near the joint, especially where there are extra-articular abscesses. Large abscesses of the prepatellar bursa, a condition which frequently follows septic adhesions in the neighbourhood of the knee-joint, is often very difficult to diagnose from a true arthritis. When the patella is floated up by an uninfected effusion into the joint the diagnosis is still more difficult.

The clinical signs of a septic arthritis of the knee-joint in addition to the swelling from effusion into the infrapatellar pouches are pain, heat, œdema and fixation of the joint.

The pain is often the "starting pain" of ulceration of the cartilages of the joint, in addition to the pain of distension of the capsule, and is most marked when relaxation of the thigh muscles takes place in sleep. The œdema is of thigh and leg and is characteristic; an uninfected hæmarthrosis of the joint will give almost every clinical sign of acute arthritis but not œdema of the thigh or leg. The joint is fixed in flexion.

The temperature is characteristic; there is almost always a history of a rigor on board the hospital ship.

As these cases arrived after seven to twelve days had elapsed from the time of the infliction of the original wound, the expectant period of treatment was over and the cases had developed into an acute arthritis or had quieted down before reaching the base hospital.

Experience of these cases leads to the certain belief that the knee-joint can take care of certain degrees and amounts of infection without surgical treatment, provided rest is given to the joint by a splint devised to fix the limb from the level of the great trochanter above, to and including the ankle-joint and foot below.

The essentials of treatment are :—

(1) *Fixation of the Joint, with extension.*—The fixation is well obtained by the use of a Neville splint, a posterior splint with a footpiece reaching above as high as the ischial tuberosity and slightly flexed at the knee. A Thomas knee splint gives equally good results and allows extension; in cases where there is no evidence of ulceration of articular cartilage, elastic tubing is sufficient; in cases with starting pains, strapping extension will be required

(2) *X-ray Examination.*—This gives accurate information of the presence of a projectile lodged in the joint and of the amount of comminution of the bones. If the condyles are shattered or the head of the tibia extensively comminuted it is best to be prepared for primary amputation.

(3) *Aspiration of the Joint.*—This is the key of the treatment of injuries to the joint. Bacteriological examination by slide or culture medium is helpful in the doubtful cases, but where there is obvious pus or a cloudy effusion there is no need to wait. The time that elapses before the bacteriological examination results arrive is often very prejudicial to the welfare of a joint undergoing rapid disintegration.

Except in cases where there is lodgment of a piece of shell casing in the joint or in the bones of the articulation or comminution of the bones, the joint should be washed out with saline or weak perchloride solution, and ether or formalin and glycerine two per cent freshly prepared, left in the joint. Of all intra-articular methods of treatment the best results seem to be obtained by the use of ether or formalin.

In cases where, after a very careful preliminary inspection of the condition under an anæsthetic, there seems to be a possibility of a portion of the joint having become shut off from the general infection, it is unwise to attempt much manipulation. It is sufficient to wash out the suprapatellar pouches alone.

The aspiration wound is enlarged by making a small incision above the patella in cases where the effusion is infected. This wound is left open.

The limb is put up in fixation with extension, and fomentations are applied frequently to the joint. The application of heat to the joint seems to have the most valuable effect in promoting congestion around the knee-joint and the fomentations withdraw a continuous effusion from the wound.

The joint may be washed out again and formalin in glycerine injected if pain and swelling and temperature are not better in three days. If this is still ineffectual recourse should be had to wide division of the ligaments of the joint with flexion or excision of the joint, removal of the sharp posterior sawn edge of the condyles and pegging the two bones together by a pin or spike.

(4) *Wide division of the patellar* tendon and lateral ligament of the joint with section of the crucial ligaments and removal of the semilunar cartilages gives perfect drainage to the post condylar pouches, the most important synovial pouches to drain and the pouches most difficult to drain by any means short of this, or by excision of the joint. The leg is put up on its outer side in acute flexion. At the same time search must be made for the openings of the semimembranosus and other bursæ in connexion with the

joint. These may be opened widely to prevent the subsequent collection of pus in these pouches.

Continuous irrigation of the exposed articulation with weak hypertonic saline solution or glycerine and saline usually brings the temperature down in a few days.

The knee must not be left flexed for more than five or seven days or such contraction of the hamstring muscles takes place that excision becomes necessitated in order to straighten the legs. Attempts to forcibly straighten the leg are attended with risk of damage to the popliteal vessels.

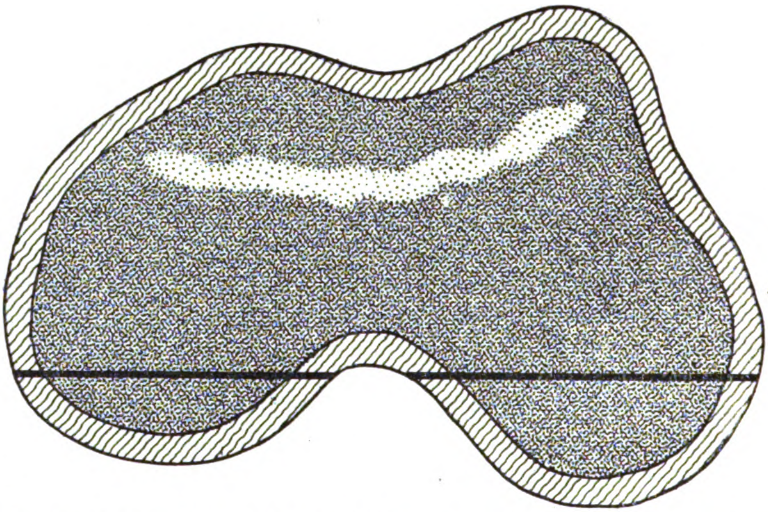

Fig. 1.—Acute arthritis. Excision of the knee. The cancellous face of the sawn section of the femur through the widest part of the condyles. The same section is made in Carden's amputation.

The thick black lines show the lines of section of the back of each condyle which give free drainage of the intercondylar space.

In one of our cases death occurred from pulmonary embolism due to thrombosis of the popliteal vein: the vein had been injured by attempts to straighten the leg two days before.

(5) *Excision of the Joint* may be necessitated in order to straighten the leg after the wide division of ligaments with flexion. It is advised as a primary operation when there is comminution of the condyles of the femur or the head of the tibia, and sufficient bony substance left to allow good adaptation of the excised ends of bone. If there is gross comminution with septic arthritis the chance of osteomyelitis of the femur or tibia and infection of the

cancellous bone of the condyles or head of the tibia is such that primary amputation should be performed.

Excision of the joint, in these delayed cases reaching base hospitals, is a particularly successful operation ; it must be remembered that the best that surgery can offer a man with acute arthritis of the knee-joint is an ankylosed knee. To consider the possibility of gaining a movable joint is to gravely underestimate the severity of the condition.

A valuable modification of the ordinary operation of excision of the knee-joint was suggested and carried out by Colonel Ballance, A.M.S. The sharp posterior margin of the sawn condyles is removed by horizontal saw cut : this allows a tube to be placed behind the region of the joint. Drainage of the intercondylar and postcondyloid pouches is thus completely established ; there is always a tendency for pus to extend up and down the muscular and fascial planes of the leg and thigh. Nor is there danger of this tube pressing upon the popliteal vessels if popliteal pressure is carefully avoided. The danger of this sharp edge ulcerating through the popliteal vessels is also thus avoided : secondary

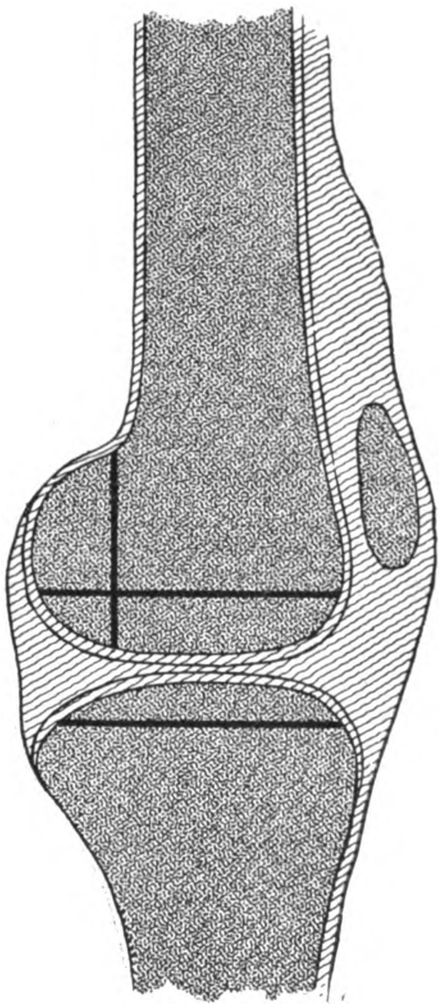

FIG. 2.—Acute arthritis. Excision of knee. *Diagram* of lines of section of femur and tibia. The adductor tubercle is not removed. The patella is removed or drainage is imperfect. The projecting posterior part of each condyle is removed, which gives good drainage of the post-condylar and intercondylar synovial pouches. The bones are fixed by pegging with a steel spike. The back of the joint must be free of splint or bandage pressure, or pus will track down the leg, and up the back and sides of the thigh, and secondary hæmorrhage from one of the popliteal vessels will be likely to occur.

hæmorrhage necessitating amputation has followed two accidents in our practice.

Excision or even the more radical operation of amputation must not be postponed too long. In the early history of the surgery of this campaign the conservative methods which were the crown of modern surgery have unfortunately resulted in radical operations being postponed too long until the final operation came too late to save and beyond the power of the patient to rally.

The indication for the radical operation, the time when temporizing methods of treatment have to be abandoned, can be seen more surely in the aspect of the patient than in any examination of local condition of the knee or study of temperature charts. The facies is characteristic and wasting is rapid and extreme. Young soldiers fail beneath the siege of pain and loss of sleep far sooner than men of 35 to 40.

After excision of the joint the bones may be fixed with a peg or spike if there is room for drainage behind the condyles: this is established as previously described by horizontal section of the posterior sharp sawn edge of the condyles. If there is doubt of sufficient room for drainage the two surfaces are separated by ¼ inch by application of strapping extension to the foot and leg : a tube is placed for a week or more between the excised ends of bone. The leg is put up in plaster with lateral iron bands to support the excised articulation and with anterior and lateral interruption to allow of dressing. Lint boiled in vaseline and applied between the leg and the iron bands and to the posterior plaster edges prevents the soakage of pus into the plaster casing and around the posterior band.

No posterior splint is applied in the cases where the excised bones are spiked or pegged together ; pressure from the posterior splint obliterates the popliteal space, and pus, instead of escaping by the lateral openings, is forced to track upwards into the thigh or downward among the muscles of the leg. When no spike is used to fix the excised bony surfaces, a posterior splint is necessary to compensate for the sagging that takes place in the region of the excised bones. Extension alone is insufficient to correct this sagging. We have found that internal splinting by a long nail or spike more efficient than any form of external splint.

Slight extension is sufficient to secure separation of the sawn edges. The limb is slung from a Balkan rest with or without a running pulley.

(6) *Secondary Amputation*, preferably a "Carden" amputation, is the final operation. Section of the femur through the condyles just below the epiphysial line avoids opening the medullary cavity

and preserves the adductor tubercle. At a later stage the projecting end of the femur can be resected subperiosteally when granulation is complete. This also preserves the insertion of the adductor muscles as far as possible; in the case of many men whose life is largely spent in the saddle, the preservation of as much of the riding muscles as possible is essential. If there is comminution of the condyles an amputation higher up is necessitated; our best results are obtained by a short posterior flap of all tissues of the ham, with a skin flap anterior, dissected carefully from the supra-patellar synovial pouches. Drainage must be carefully maintained and the skin flap only applied direct to the sawn cancellous tissue when septic absorption is over.

No mention is made in this paper of drainage of the knee-joint by means of tubes in the joint. Tube drainage of the knee-joint at the time and in the stage of infection in which these cases arrive is not effectual as a surgical procedure. The posterior condylar pouches cannot be drained by any tube that does not pass through the posterior ligament of the joint and thereby lie in dangerous proximity to the popliteal vessels. The key to the drainage of the knee-joint is the drainage of these posterior condylar pouches. Section of the lateral ligaments of the joint, in order to allow the presence of a tube without pinching it, has to be very thoroughly performed. Incisions on either side of the patellar tendon and opening the joint have been very successful in avoiding disorganization of the joint, but only when performed upon the beach or in an early stage on board the hospital ships. We have had five instances of this operation; in these cases the good results were due to the avoidance of secondary infection in transit, most satisfactory splinting of the leg and the shutting off of the synovial pouches by adhesions. These cases were very ably operated on and effectually immobilized at a stationary hospital.

The bacteriology of the effusion in these cases shows the streptococcus as the dominant organism in the rapidly disorganizing joints following acute septic arthritis; even if the presence of the streptococcus is obscured in the earlier cases by luxuriant growth of other organisms, it eventually appears as the predominant one in the later stages of joint destruction.

Treatment of the Four Varieties of Gunshot Injury to Knee-Joint.

(1) *The First Type:* that of clean perforation without lodgment of projectile. Immobilization on a splint combined with aspiration is sufficient. The aspiration determines the presence of a low form

of infection, relieves the pain due to distension of the joint and allows the introduction of glycerine and formalin solution. The joint should not be flexed and should be treated with the utmost gentleness. No attempts to break down adhesions should be made until two months have elapsed since the cessation of all active symptoms for fear of re-awaking some dormant focus of infection.

(2) *The Second Type :* that of traumatic arthritis from wounds of the lower third of the femur. Aspiration and examination of the effusion should be made before the operation to secure sufficient and dependent drainage to the fractured ends of bone is performed. If the joint effusion is uninfected it will remain so, even in the presence of a large undrained extra-articular abscess, provided that no injury is done to the reflection of synovia at the operation.

(3) *Lodgment of Projectiles* in the joint: in these cases, owing to the time that has elapsed, there will be no further need of expectant treatment. The arthritis will have been established by the time the case is admitted. X-ray examination determines the position of the bullet or fragment. Rifle bullets or shrapnel balls can be safely left undisturbed even if embedded in the condyles or lying free in the joints until aspiration and washing out of the joint has been tried. The inevitable extra traumatism that is inflicted by attempts to remove the projectile and the disturbance of adhesions caused by flexion of the joint, re-opens the post-condyloid synovial pouches which may have been shut off from the general infection of the joint. Extension and elevation of the limb in an immobilized position combined with aspiration, washing out the joints and the introduction of formalin and glycerine will very frequently lead to relief of the arthritis. The projectile can be removed by subsequent operation when sufficient time has elapsed to ensure that no dormant focus of infection exists. The applications of hot fomentations to the joint if the incision, made to perform aspiration and lavage, be left open, has a remarkable effect in ensuring the removal of effusion subsequently poured out. Four cases in this series have been treated successfully in this way and have been sent to England in a quiescent state.

The treatment of fragments of shell casing or bomb lodged in the joint or in the bones forming the articulation should be by removal, except in the rare cases that appear quiescent. Lodgment of these fragments in the condyles produces as a rule such a violent reaction after removal and the flexion of the joint, necessitated by attempts at removal, that it is often better to perform an excision of the joint as a primary measure. Lodgment of fragments in the

condyles of the femur appear to be consistently followed by a graver reaction than similar lodgment in the head of the tibia or in the patella.

(4) Wounds opening into the joint with comminution of the bones forming the articulation. The treatment of this condition must be more radical. In these cases again destruction of the condyles of the femur is more serious than destruction of the articular surface of the head of the tibia and very much more so than comminution of the patella.

Comminuted fracture of the condyles usually necessitates primary amputation unless there is sufficient sound cancellous tissue left to allow of an operation for excision of the joint. Usually, however, the condyles are badly necrosed with black and stinking cancellous bone. If there is reason to fear infection of the cancellous tissue beyond the epiphysial line or of the medulla, primary amputation should be immediately performed.

Destruction of the articular surface of the tibia, however, provided that there is no gross fracture involving the cancellous tissue of the head of the bone, allows sometimes of conservative methods. Among our series are two cases of comminution of the tibial articular surface with division of the patellar tendon; both cases caused by side to side wounds. In these two cases the rest of the joint and the two synovial pouches, post-condyloid and suprapatellar, were shut off from the general infection. The greatest care and gentleness were given to these cases; the joint was not flexed, the suprapatellar pouches were aspirated and formalin and glycerine injected. Both made uninterrupted recoveries; subsequently portions of the articular surface of the tibia and the semilunar cartilages were gently removed.

Destruction of the patella is the least dangerous. The fragments may be gently removed and the wound enlarged so as to allow freer drainage, and the contused edges of the original wound excised. On no account should the joint be flexed or the synovia injured. Among our series we have had four cases of this condition which have made complete recovery; these left hospital for England with a reasonable expectation of a fairly movable joint in the future. In all these cases there is a coincident hæmothorax with great distension of the suprapatellar pouches. In two the hæmothorax was uninfected, in two infected by staphylococci; the effusion was removed by aspiration and lavage, and glycerine with formalin injected in one of the infected and one of the uninfected cases.

The excision of the primary wound is nearly always advisable; the edges are usually torn, bruised and necrotic.

In all cases of excision of the joint, extensive operations on the joint surfaces or amputations, the sciatic nerve is always blocked with novocain two per cent, and in amputations the skin and subcutaneous tissues infiltrated with the same solution.

Surgical shock after excision of the knee-joint is severe even if the sciatic nerve be blocked. The previous days or weeks of pain, fever and sleeplessness, added to the depressed vitality of these patients, after the prolonged dysentery and other debilitating conditions under which life is maintained, add greatly to the danger of this operation. Intracellular or rectal infusions of saline have to be kept up for two or three days intermittently, for shock is often delayed to the second or third day.

In one series of cases we have had one death from surgical shock on the second day after operation.

The indications for primary amputation in gunshot injuries of the knee-joint are :—

(1) Extensive comminuted fracture of the bones of the joint, especially in the cases of comminution of the condyles.

(2) Injury to sciatic or popliteal nerves or thrombosis of the popliteal vessels.

(3) The supervention of emphysematous gangrene or any grave ascending infection in the region of the joint.

The indications for secondary amputation are :—

(1) First and foremost the incapacity of the individual to withstand the continued pain, fever and sleeplessness which will of necessity follow unsuccessful attempts at lavage of the joint ; or to bear the shock of an excision. This incapacity to stand further surgical treatment is plainly written on the faces of the patients and amputation must be performed without delay.

(2) Infection of the cancellous or medullary tissue of the long bones in addition to acute arthritis is an immediate indication for amputation.

(3) The unsuccessful establishment of drainage of the joint after a reasonable interval of time.

(4) Septicæmic symptoms prolonged after drainage is apparently well established.

(5) Secondary hæmorrhage from popliteal vessels from injudicious attempts to secure drainage by tubes in close relation to the vessels, or hæmorrhage from ulceration of popliteal vessels by the posterior sharp sawn edge of the condyles after an operation for excision of the joint.

(6) Fracture of the femur or tibia or arthritis of the ankle-joint coinciding with infection of the articulation of the knee.

(7) Thrombosis of the popliteal vessels from trauma or infection.

(8) Supervention of a grave ascending cellulitis.

The results of our treatment of thirty-seven cases of gunshot injury to the knee-joint treated in three months, September 1 to December 30:—

(1) *Three cases* of projectiles in the joint or embedded in the articular ends of the bones. Quiescent on arrival. Treated by rest, extension, fomentations or wet dressings. Sent home with projectiles still in the joints or bones. No operation.

(2) *Three cases* operated upon on board hospital ships or in the 17th Stationary Hospital. Quiescent on arrival. Treated by rest, extension and fomentations or wet dressings.

(3) *Four cases* of lodgment of projectiles, rifle bullet or shrapnel ball, in the joint; mild infection; successful removal; introduction of formalin and glycerine in two cases.

(4) *Four cases* of fractured patella with hæmothrosis; two infected; two uninfected; two of these not operated upon. In two lavage and formalin and glycerine injection employed.

(5) *Two cases* of comminution of tibial articular surface with shutting off of the rest of articulation. Aspiration and formalin and glycerine injection into the joint. Wounds treated with iodoform ten per cent in ether.

(6) *Two cases* of complete division of patellar tendon and lateral ligaments of the joint; articulation put up in extreme flexion; hypertonic saline irrigation. One died from thrombosis of popliteal vessels with pulmonary embolism; the other came to amputation seven days after operation.

(7) *One case* of removal of both femoral condyles for compound comminuted T-shaped fracture into the knee-joint. Four months later the tibial articulating surface was excised; the bones fixed together by a plate; three inches shortening. Good expectation of a serviceable leg.

(8) *Six Excisions* of the knee-joint; one died from shock; another died from pulmonary embolism (see par. 6); one amputated for secondary hæmorrhage; three completely successful.

(9) *Primary Amputations; three cases* all for extensive comminution of bones forming the articulation.

(10) *Secondary Amputation; four cases* (including one of par. 6); one for septicæmia and profound intoxication in spite of complete drainage established by section of patellar tendon and lateral ligaments of the joint; the articulation being put up in extreme flexion. One was necessitated by secondary hæmorrhage

after excision of the joint. Two were called for after ineffectual attempts at drainage.

(11) *Deaths.*—Five. One from delayed shock after excision of the joint performed two days previously. One from pulmonary embolism (see par. 6). Three deaths resulted from profound septicæmia.

This series does not include the large number of cases of traumatic arthritis of the knee-joint coincident with injury to the femur: such injuries as fracture to the lower third of the bone or muscular wounds. The inclusion of these cases would very greatly have improved our results, but do not properly come under the title of this paper.

It must be remembered that the wounded are exposed to the infection introduced by flies, the dust of a most filthy and highly infected soil, also complicated by excessive heat and frequent *Bacillus coli* contamination, by the extreme difficulty of efficient treatment, and the grave degree of exhaustion exhibited by many of the soldiers before the infliction of the wound. Compared to these difficulties we hear of the wounded on the Western Front in France arriving at base hospitals within twenty-four hours after being wounded. All our cases of septic arthritis were profoundly intoxicated by most highly virulent strains of streptococcal infection.

No mention is made in this series of recovery of function. It is possible that some cases might result in recovery with movable joints eventually. All our cases were sent to England when convalescence was established and the joint quiescent. No attempts to establish movement were made for fear of awakening some dormant foci of infection.

THE ELECTRICAL REACTIONS OF MUSCLES BEFORE AND AFTER NERVE INJURY.

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When the nerve leading to a muscle is damaged or destroyed, the muscle shows a series of changes in its response to the electric current which are grouped together under the name "reaction of degeneration." These changes may be classed conveniently under two heads: (1) Changes in the character of the electric current required to excite the muscle, and (2) changes in the response of the muscle to excitation. The changes in the response consist in the reduced rapidity, slow subsidence and weak power of the contraction and sometimes in its localization to the neighbourhood of the electrodes. These suffice to give a rough idea of the state of the muscle, but it is very doubtful if the most exact measurements of them would give information which could be regarded as quantitative, since they depend not only on the degree of degeneration, but also on such transitory conditions as the temperature of the limb, whether it has been massaged recently or not, etc.

In regard to the changes classed under the first head the position seems more hopeful, and in recent years more and more stress has been laid on the measurement of the current required to excite, as giving a true indication of the state of the muscle and its nerve. It is the purpose of the present inquiry to find out, if possible, more exactly the relation between the state of the muscle and the nature of the current required to excite it, to investigate the causes underlying this relation and to see how much diagnostic information may be gained by the different methods at present in vogue.

In the ordinary method of testing with faradic and galvanic currents the stimulus may be varied at will as regards its strength but not as regards its duration. The faradic current rises rapidly to its maximum in about 0·0001 second (the exact constants depending on the dimensions of the coil) and falls more slowly to zero. In practice the current is repeated many times a second, but this is simply a matter of convenience, as it allows the contraction to be more easily observed; the muscle responds as readily to a single shock as it does to a series of shocks. The galvanic current rises

instantaneously to its maximum value and remains at the same level until it is turned off. Without special apparatus its duration cannot be controlled if it is much less than half a second, and if it is greater than this its duration makes no difference to the efficacy of the current. Thus we are confined to a very brief current and a very long one, and there is nothing between the two. With this arrangement it is easy to tell whether the nerve to a muscle is damaged or not, since a muscle with intact nerve supply will respond to the brief faradic current, whereas one with a damaged nerve supply will not respond to this, but will respond to the longer galvanic current. However, this information is entirely qualitative and it does not allow us to make any estimate of the exact state of affairs. Some additional information may be gained from the alterations in the strength of the current required to excite, but unfortunately such changes may be due to altered skin resistance, increase of fluid in the subcutaneous tissues, etc., quite apart from any change in the condition of the nerve supply. At the same time it is clear that the degeneration of the nerve causes an increase in the duration of the current required to excite the muscle, and this suggests that if we could measure the least effective duration it might give valuable quantitative information about the condition of the muscle and nerve.

For this purpose the method of condenser discharges has been introduced by Cluzet,[1] in France, and Lewis Jones[2] in this country. This method depends on the fact that the discharge of a condenser through a constant resistance varies in duration according to the capacity of the condenser. The discharge starts at its maximum value and falls off gradually, and with the sets of condensers in use at present it is possible to obtain currents whose total duration varies from 0·00004 second to 0·005 second. By inserting special resistances even longer discharges may be obtained. With these currents it is found that the more severe the injury to the nerve appears to be, the greater is the capacity of the condenser (and, therefore, the longer is the duration of the discharge) required to excite the muscle. Thus the method would seem to give all the information which could be desired from a clinical point of view; we have only to find the least capacity of condenser which will excite the muscle and this will give a measure of the severity of the injury. Unfortunately the principles which underlie this method

[1] *Annales d'Electrobiologie*, 1903, 1907.

[2] *Proc. Roy. Soc. Med.*, 1913, vi, p. 49.

have never been thoroughly decided, and the conclusions which are based on it are derived almost entirely from observations on the human being, and very little from experimental work on animals or on isolated muscle and nerve preparations. Indeed, two years ago, Laugier[1] pointed out that a consideration of the facts which are known in regard to the electrical stimulation of cold-blooded tissues shows that there is a serious fallacy in the condenser method as it is used at present. These facts are stated briefly in the following section.

The Relation of Current Strength to Current Duration in Cold-blooded Tissues.

Within the last ten years the precise conditions under which an electric current will stimulate the excitable tissues of cold-blooded animals has been worked out with some approach to certainty. The relations between the condition of the tissue, the form of the current, its strength and its duration, have been studied exhaustively and reduced to mathematical terms by Keith Lucas,[2] Lapicque,[3] A. V. Hill,[4] and others, and though there is still some difference of opinion as to the theoretical interpretation of these relations, their exact form is no longer in doubt. The most fruitful results have been obtained by the use of constant currents, that is, of currents whose strength rises immediately to a fixed value and remains at that value as long as the current is flowing. In such currents there are only two variables to consider, the strength and the duration, and both of these are easily controlled. When these currents are applied to a simple tissue such as the sciatic nerve of a frog, it is found that currents of less than a certain minimal duration will not excite however strong they may be; with longer currents the strength required to excite becomes less and less as the duration increases, until eventually it falls to a constant level which cannot be reduced further by increasing the duration. This relation is shown in fig. 1, which is constructed from an experiment by Keith Lucas[5] on the sartorius muscle of the toad. In this case, however strong the current may be, it will not excite at all if its duration is less than 0·003 second. With slightly longer durations

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[1] *Biologie Médicale*, 1914, p. 89.
[2] *Journal of Physiol.*, 1910, xl, p. 225, etc.
[3] *Ibid.*, 1908, x, p. 601; 1909, xi, p. 1009, etc.
[4] *Ibid.*, 1910, xl, p. 190.
[5] *Ibid.*, 1907, xxxv, p. 321, fig. 7.

a very strong current is needed, and the strength falls off gradually as the duration is increased. Eventually the minimal strength is reached, and when the potential difference is less than 0·076 volts the current will not excite, however long its duration may be. Thus the current which will excite the muscle must possess a duration longer than 0·003 second and a strength greater than that given by 0·076 volt. In between these limiting values the relation between strength and duration is expressed by a curve which is convex to the origin.

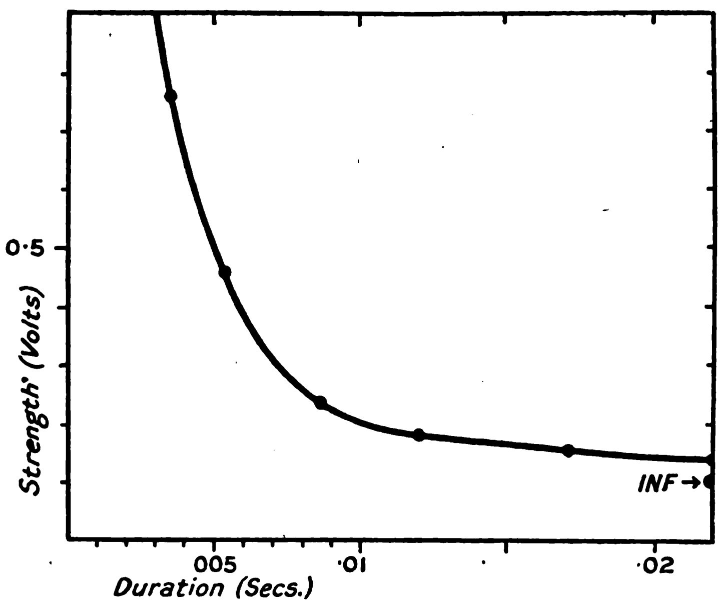

Fig. 1.

A curve which is almost identical with fig. 1 is found for every preparation of the toad's sartorius, the only difference being that the minimal current strength required to excite will naturally depend on the resistance of the muscle, the dimensions of the electrodes, etc. In every case the current required to excite begins to increase when the duration is reduced much below 0·02 second and is doubled when the duration is about 0·01 second. This holds good for the sartorius of the frog as well as that of the toad, and for the gastrocnemius as well as the sartorius. A curve of the same form is given by the sciatic nerve of the frog or toad and by

the nerve fibres in the substance of the muscles, but in this case the time factor is much less important, and the minimal strength does not begin to rise until the duration is less than about 0·003 second. Ventricular muscle shows a much slower reaction than voluntary muscle, the minimal strength rising at about 2·0 seconds. In every case which has been examined (and this includes the muscles and nerves of a variety of cold-blooded animals) the curve is of the same form and is approximately constant for similar tissues under similar conditions.

Various equations have been found to fit the curve. That of Weiss[1] is the simplest and that of A. V. Hill[2] conforms most accurately to the experimental results. Weiss's equation is—

$$i = a + bt,$$

where i is the current strength, t the duration and a and b are constants. Hill's equation is—

$$i = \frac{\lambda}{1-\mu\,\theta^{t}}$$

where λ, μ and θ are constants. The constants are easily calculated in either case and in Hill's equation they are given a definite physical interpretation. However for all practical purposes the curve may be defined by two factors, one of which is the least current required to excite at infinite duration and the other a time factor depending on the rapidity of the tissue to respond to the current. This factor is given approximately by the duration at which the current strength must be doubled, a quantity which is equal to the ratio $\frac{a}{b}$ in Weiss's equation. Lapicque has proposed the name "Chronaxie" for this quantity, and his nomenclature will be adopted in the following discussion. It follows then that for any given tissue a determination of the duration at which the current strength must be doubled suffices to fix the strength-duration curve for that tissue.

The characteristics of this curve have been insisted on at some length because of its great importance in connexion with electro-diagnosis. In the first place it is clear that the least duration which a current must possess, if it is to stimulate the excitable tissues of a cold-blooded animal, depends not only on the nature and condition of the tissue but also on the strength of the current. A strong current will excite at very much shorter durations than a weak current. The same holds good for condenser discharges as

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[1] *Archiv. italiennes de Biol.*, 1901, xxxv, p. 413. [2] *Loc. cit.*

for constant currents, and, therefore, the least effective duration of a condenser discharge will depend on the strength of the discharge as well as on the state of the tissue to which it is applied, and if the excitability of the tissue happens to change the least effective duration corresponding to a given strength of current will change too. If the same reasoning can be applied to mammalian muscles and nerves it is clear that the method of condenser discharges cannot give a true indication of the state of affairs unless precautions are taken that the strength of the discharge shall always bear the same relation to the strength required when the duration is infinitely long. In the ordinary condenser method this precaution is not taken and Laugier's criticism of the method rests on this ground. Clearly then, to make sure that this objection is valid it is important to find out how far the relation expressed in Weiss's or Hill's equation is true for mammalian as well as for cold-blooded tissues.

The determination of the strength-duration curve is important for another reason. In the cold-blooded tissues the time factor of the curve, the "chronaxie" is constant for similar tissues examined under similar conditions and differs greatly from one tissue to another. Thus the determination of the curve makes it possible to distinguish clearly the nature of the tissue upon which the stimulus takes effect. For instance, it is possible to tell whether the current applied to a muscle stimulates the muscle fibres directly or indirectly through the medium of the intramuscular nerve fibres. The value of this will be seen hereafter.

The Relation between Current Strength and Current Duration in Healthy Muscles.

The apparatus required for the determination of the strength-duration curve in human subjects must be capable of delivering a constant current varying in duration from a ten-thousandth to a tenth of a second at a potential varying from one to a hundred volts or more. In practice the duration was controlled by a Lucas pendulum[1] and the potential by a potentiometer connected to the 200-volt mains (continuous). The potentiometer consisted of two dial resistance boxes, the resistance in the two together being maintained at a constant value of 1000 ohms. The current was led off from the potentiometer through a 500-ohm resistance to the

[1] *Journ. of Physiol.*, 1908, xxxvii, p. 460.

stimulating electrodes. This resistance was inserted to cut down the current which would otherwise pass when the short circuit key, K_1 is closed. In the circuit from the potentiometer were two knock-down keys, one in the circuit through the patient and the other in a short circuit which avoided the patient and returned the current direct to the potentiometer. The two keys were opened by means of the pendulum and the interval separating their opening could be varied from 0·0001 to 0·2 second. The arrangement of the connexions is shown in fig. 2. The resistance boxes are lettered A, B and C, and the keys K_1 and K_2. When the short circuit key K_1 is opened by the pendulum the current begins to flow through the patient, and when the in-circuit key K_2 is opened

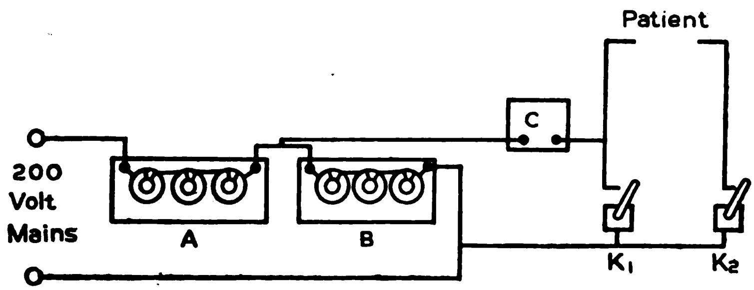

FIG. 2.

the flow ceases. By altering the ratio of the resistances in the two halves of the potentiometer the potential difference between the points A and B can be varied from 1 to 200 volts. Thus both current strength and current duration can be varied within fairly wide limits. The whole arrangement is practically identical with that devised by Keith Lucas,[1] for use in his experiments on cold-blooded tissues. No attempt was made to measure the current directly; this is not essential, since all we require to know is the strength compared with that required to excite when the duration is infinitely long; furthermore, it is impossible to measure the strength without using a ballistic galvanometer or some such method, since the currents are too short in duration to affect the usual measuring instruments and too strong to be borne comfortably by the patient if they are allowed to run for any length of time.

In the following experiments the current strength is always

[1] *Journ. of Physiol.*, 1907, xxxv, p. 819.

expressed as a multiple of that required to excite when the duration lasts for several seconds. This is given the value ten and is spoken of as the strength at infinite duration, for when the duration exceeds one or two seconds its exact value is found to make no difference to the strength.

The majority of experiments to be described were made on the tibialis anticus muscle. This is an ideal muscle for the purpose as it is easily excited and its contractions are easily observed and distinguished from those of neighbouring muscles. Moreover, it is frequently paralysed in injuries of the sciatic, poliomyelitis, etc. In working with this muscle a large pad electrode was placed under the calf to serve as the anode and a small pad 1 inch square was bandaged on to the front of the leg for the kathode. The exact position of this was found to be unimportant, but as a rule it was secured with its centre one inch from the anterior border of the tibia and two inches below the level of the head of the fibula. Both electrodes were soaked in a solution of ammonium choloride. With this arrangement the strength of current required to excite at infinite duration does not vary by more than five per cent during a series of measurements lasting twenty minutes or more. The contraction of the muscle is best detected by placing the index finger across the surface of the muscle with its tip resting on the border of the tibia. The contraction of those fibres lying immediately external to the tibia can be felt by this method when their contraction is too weak to produce any movement of the foot, or any visible deformation of the skin.

The strength-duration curves were always determined in the following way. First of all the current was made and broken after an interval of some seconds by a hand switch, and the potentiometer was adjusted so that the current was just strong enough to produce a contraction. This gave the strength at infinite duration. If this appeared to be constant after several measurements, the pendulum was set to give a current lasting for about 0·1 second and the requisite strength was redetermined. The duration was reduced still further and the strength required to excite was determined for each duration, until eventually the duration was so short that currents five or six times the value at infinite duration failed to excite the muscle. The duration was then increased to check the previous results and finally the strength at infinite duration was determined again. As a rule the results of the two sets of readings with the duration decreasing and increasing agree very well, the difference in two readings at the same duration being rarely greater than five per cent and usually less.

A typical curve for the tibialis anticus with intact nerve supply is shown in fig. 3. In this and in all subsequent figures the current strength is shown by the ordinates, the strength at infinite duration being given the value ten and other strengths expressed as multiples of this. The duration of the current is shown by the abscissæ. In the present case it will be seen that the curve rises very gradually until the duration is reduced to about 0·0003 second. As the duration is reduced still further the curve rises very rapidly

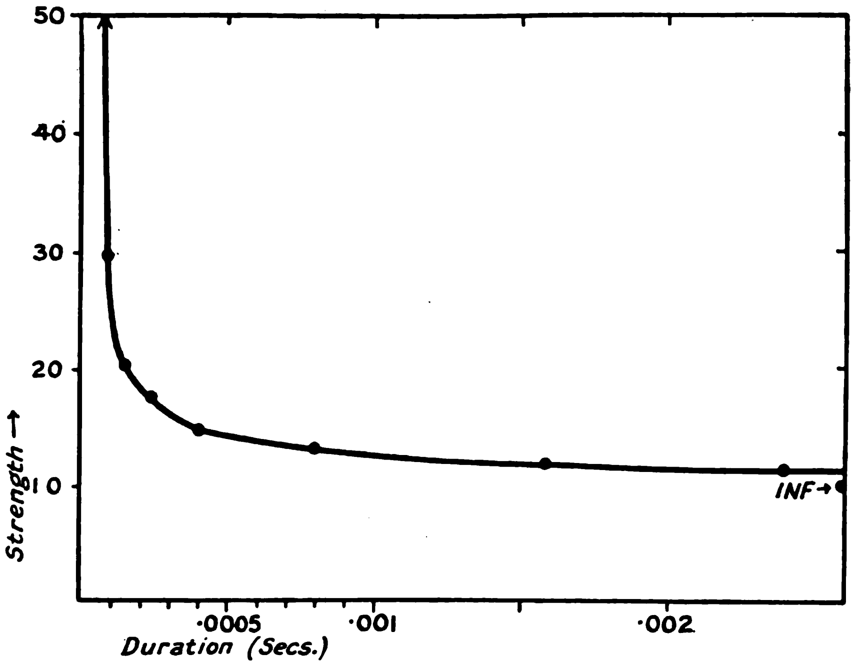

FIG. 3.

and at 0·0001 second a current over three times as strong as that at infinite duration is required to produce a contraction. As the significant durations are so short it is difficult to be certain as to the precise form of the curve, but the current strength appears to be doubled at a duration of about 0·00018 second. Thus the chronaxie in this case is 0·00018 second. A value which varies between 0·00025 and 0·00008 second was found in all the healthy muscles examined, and this holds good not only for the tibialis anticus, but for all the other muscles which were investigated, the biceps, the flexors and extensors of the forearm, the extensors of the thigh and the small muscles of the thumb.

The actual values of the chronaxie for healthy muscles in six different individuals are shown in Table I.

When the kathode is applied to a nerve trunk instead of to a muscle the chronaxie is on the whole slightly longer. In the case of the external popliteal nerve the average of four determinations gave 0·00025 second. However, the measurement is more difficult than in the case of a muscle, and for this reason the difference cannot be insisted upon.

TABLE I.

CHRONAXIE OF MUSCLES WITH INTACT NERVE SUPPLY.

Muscle	Subject	Chronaxie
Tibialis anticus	a ..	0·00016 second.
,, ,, ...	b ..	0·00008 ,,
,, ,, ...	c ..	0·00015 ,,
,, ,, ...	d ..	0·00025 ,,
,, ,, ...	e ..	0·00016 ,,
Biceps	a ..	0·00012 ,,
,, ...	b ..	0·00020 ,,
Extensor longus digitorum ..	b ..	0·00024 ,,
,, ,, ,, ..	e ..	0·00010 ,,
Tensor fasciæ femoris ..	a ..	0·00008 ,,
,, ,, ,, ..	f ..	0·00015 ,,
Average value for all muscles	..	0·00016 ,,

THE STRENGTH-DURATION CURVE IN DENERVATED MUSCLES.

The simplest case to consider is one in which there has been a complete section of the nerve, the muscle being examined at a time when all the nerve fibres peripheral to the injury must have degenerated, and before there are any signs of recovery. The observations to be recorded in the present section were made on the tibialis anticus at different times after the section of the sciatic or external popliteal nerve. Records were made from four patients showing the syndrome of complete sciatic division (due to gunshot wounds) and in three of these the division of the nerve was verified by operation. The fifth case is one of injury to the external popliteal. The following is a short summary of the cases.

Case 1.—The patient was shot through the right leg on March 10, 1915. There was complete paralysis of all the muscles below the knee, and complete sensory loss over the area supplied by the sciatic. There was no pain and not much wasting of the muscles. Tested in the ordinary way the tibialis anticus showed the complete reaction of degeneration. As there were no signs of recovery the sciatic was exposed on October 30, 1915, and it was

found to be completely divided with a gap of 2½ inches between the ends. Fig. 4 shows the strength-duration curve determined on September 28. The curve is of the same form as that in figs. 1 and 3, but the slope is much more gradual and the current strength is doubled at 0·0095 second and increased to five times the threshold value at 0·0027 second. Thus the chronaxie is 0·0095 second. In the other leg, which was uninjured, the tibialis anticus gave a chronaxie of 0·00012 second, the usual value for muscle with intact nerve supply. Thus the chronaxie of the denervated muscle is

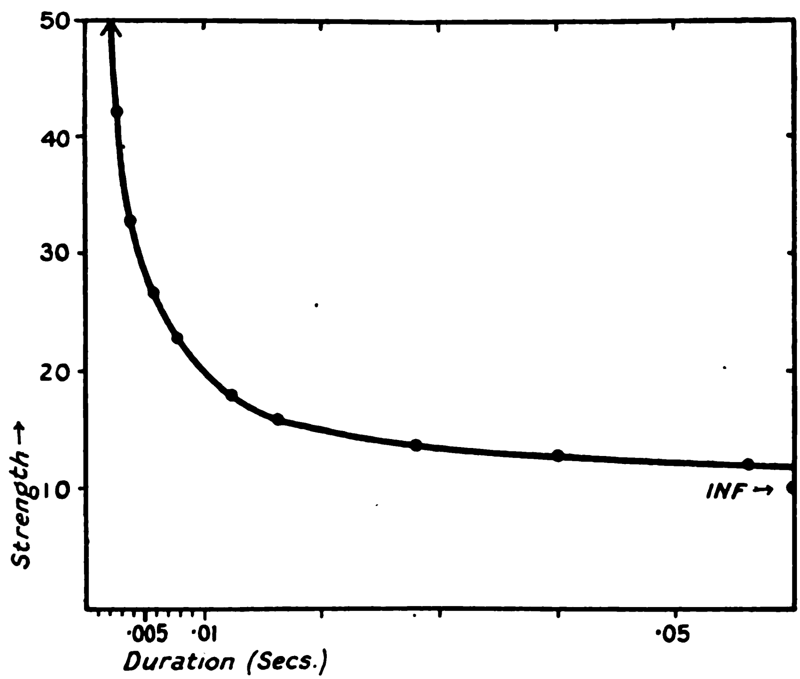

FIG. 4.

nearly 100 times as long as that of the corresponding healthy muscle. The determination was repeated on December 4, nearly two months after the operation and three months after the first determination. The curve coincides within the limits of error with the earlier determination, the chronaxie being 0·011 second.

Case 2.—In this patient the left sciatic was wounded in March, 1915, and a month later the wound was opened and a portion of the nerve which had been converted into scar tissue was removed and the ends of the nerve were sutured. There was the usual

motor and sensory loss and there were no signs of recovery when he was examined. The curve was determined on September 17, 1915, and again on September 30. In both cases the chronaxie was 0·011 second and the curves were almost identical with those in Case 1.

Case 3.—The leg was shot through in September, 1915, and the sciatic was exposed on October 11, and found to be divided. The ends were cleaned and sutured, and the curve was determined on November 3 and again on December 10. The chronaxie had the

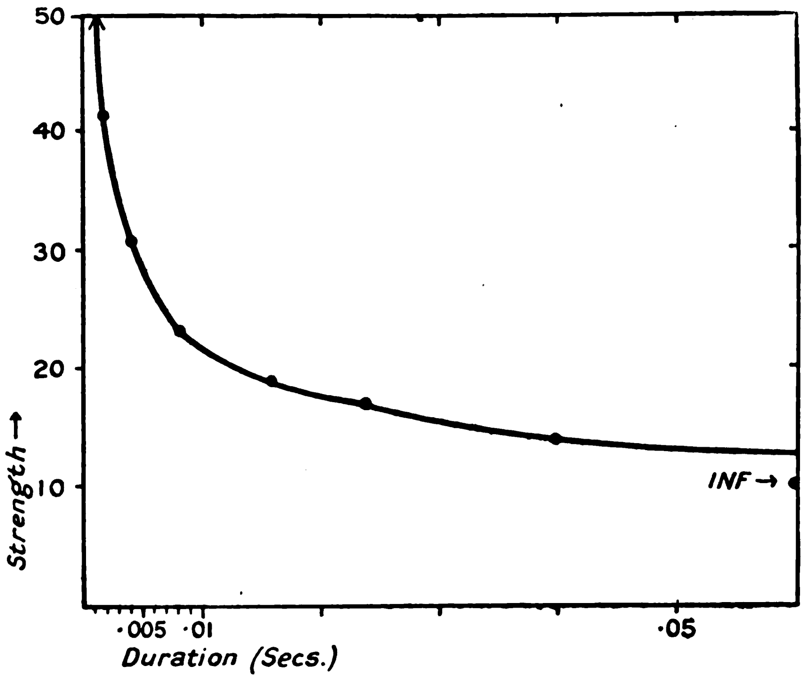

Fig. 5.

value 0·013 second at the first determination and 0·010 second at the second. For very strong currents the limiting durations are shorter than in Case 1, but otherwise the agreement is very close. The curve for November 3 is shown in fig. 5.

Case 4.—The patient was shot through the lumbo-sacral plexus on the right side in May, 1915, and had all the signs of complete division of the sciatic. He was examined once at the beginning of September and again a month later. The chronaxie was 0·010 second at the first determination and 0·0095 at the second. There

were no signs of recovery when the patient was discharged, but the condition of the nerve was never verified by operation.

Case 5.—The patient's fibula was fractured at its head by a bullet in June, 1915, and there was at once complete paralysis of the muscles supplied by the external popliteal. There was no recovery when he was examined on November 4. The chronaxie in this case was 0·013 second and the curve agrees closely with those in figs. 4 and 5.

The different values of the chronaxie in these cases are collected in Table II, and it will be seen that they give a mean value of 0·011 second with extremes of 0·013 and 0·0095 second.

From one point of view these results are only what might have been expected. The muscles had lost their response to faradic currents and retained that to galvanic currents, and therefore it is not surprising that the least duration of current which is necessary to excite them is very much longer than it is in a muscle with intact nerve supply. The form of the curve remains essentially the same though the time constant is altered, and this again is not to be wondered at in view of the fact that the same form of curve has been found for every excitable tissue which has been investigated hitherto.

From another point of view the results are certainly unexpected. In all nine curves were determined in five different subjects at intervals varying from six weeks to nine months after the division of the nerve. In all these determinations the chronaxie was never greater than 0·013 second and never less than 0·0095 second. It is true that in every case the leg had been treated with daily massage, passive movements and galvanism very soon after the injury had occurred, but even so it is surprising to find that the nature of the current required to excite varies so little with the lapse of time. As a matter of fact the temporary condition of the muscle at the moment when it is examined does not affect the curve in the least. This is shown by some observations which were made on Case 1 to test the immediate effect of massage and exercise. The right tibialis anticus was examined at 9.30 a.m. before the leg was massaged and the chronaxie was found to be 0·011 second. The leg was left motionless and exposed to cold air until 11.15 a.m. The curve was redetermined and was found to coincide with the first measurement. The leg was then massaged and exercised thoroughly for half an hour and at 12.20 p.m. the curve was determined again. The chronaxie was still 0·011 second and the curve had not altered in the least, although the contraction was certainly less sluggish than

it had been before the massage. Clearly then the curve is not affected by such transitory conditions as the temperature and state of activity of the muscle at the moment when the determination is made, and some other cause must be looked for to explain the constancy of the results with different muscles. Either we must suppose that the excitability constants do not vary as the condition of the muscle passes from bad to worse, or else the condition of the muscle does not change appreciably within the time limits investigated.

The question is cleared up to some extent by the results given by muscles to which voluntary power is returning after an incomplete injury to the nerve. These are discussed in the following section.

TABLE II.

TIBIALIS ANTICUS AFTER COMPLETE DIVISION OF THE SCIATIC WITH NO SIGNS OF RECOVERY.

Case	Time after injury	Chronaxie
1	(a) 6 months	0·0095 second.
	(b) 9 ,,	0·011 ,,
2	(a) 6 ,,	0·011 ,,
	(b) 6½ ,,	0·011 ,,
3	(a) 1½ ,,	0·013 ,,
	(b) 2½ ,,	0·010 ,,
4	(a) 4 ,,	0·010 ,,
	(b) 5 ,,	0·0095 ,,
5	(a) 5 ,, (external popliteal)	0·013 ,,
	Mean value	0·011 ,,

In Cases 1, 2, and 3 the section of the nerve was verified by operation.

THE STRENGTH-DURATION CURVE IN CASES SHOWING EVIDENCE OF RECOVERY.

The foregoing results show that in the healthy tibialis anticus with intact nerve supply the strength of current required to excite is doubled when the duration is reduced to 0·0003—0·00008 second, whereas if the nerve has degenerated the duration at which the strength is doubled is about 0·011 second. Both cases give a curve of the same type, but the curve falls much more slowly in the latter case than in the former. To understand the significance of these curves it is important to find out what happens when recovery is taking place, how the slow curve for denervated muscle becomes transformed into the rapid curve characteristic of muscle with intact nerve supply.

The ideal case to investigate would be one in which there had been a complete section of the nerve with subsequent regeneration

and commencing return of voluntary power. However, the sciatic takes many months to regenerate and cases of complete sciatic division are usually discharged long before there are any signs of recovery, The ulnar and median divided near the wrist recover much more rapidly, but the small muscles of the hand are very difficult to investigate by the present method on account of the spread of the current to neighbouring healthy muscles. Consequently the cases in the present section are limited to two of acute anterior poliomyelitis, one of toxic polyneuritis of unknown origin and one of incomplete injury to the sciatic by bullet wound. In all these cases the tibialis anticus had been completely paralysed and at the time of investigation voluntary power had just returned in some degree to it or to neighbouring muscles.

The following is a short abstract of these cases.

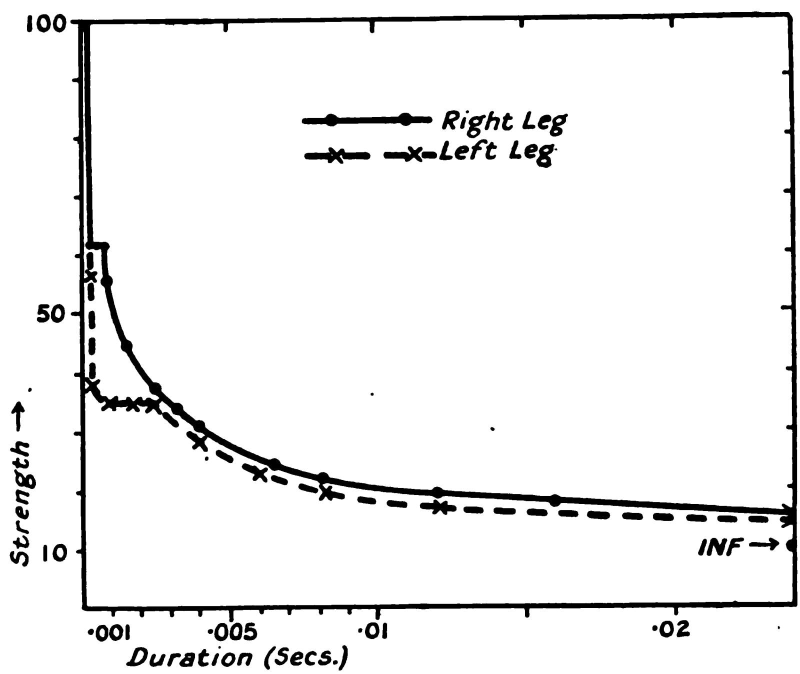

Fig. 6.

Case 6.—The patient, aged 19, had a typical attack of acute anterior poliomyelitis beginning on September 5, 1915. When he was first examined there was moderate power in the arms, but very

little in the trunk or legs. Power in the legs returned gradually during the months of November and December, when he was under observation. The muscles were examined electrically on November 27, December 8, and December 26. During the whole of this time there was no response to faradism in the right tibialis anticus, and in the left there was a slight response to very strong currents. A slight degree of voluntary power was present on either side, but the left tibialis anticus was always stronger than the right and its

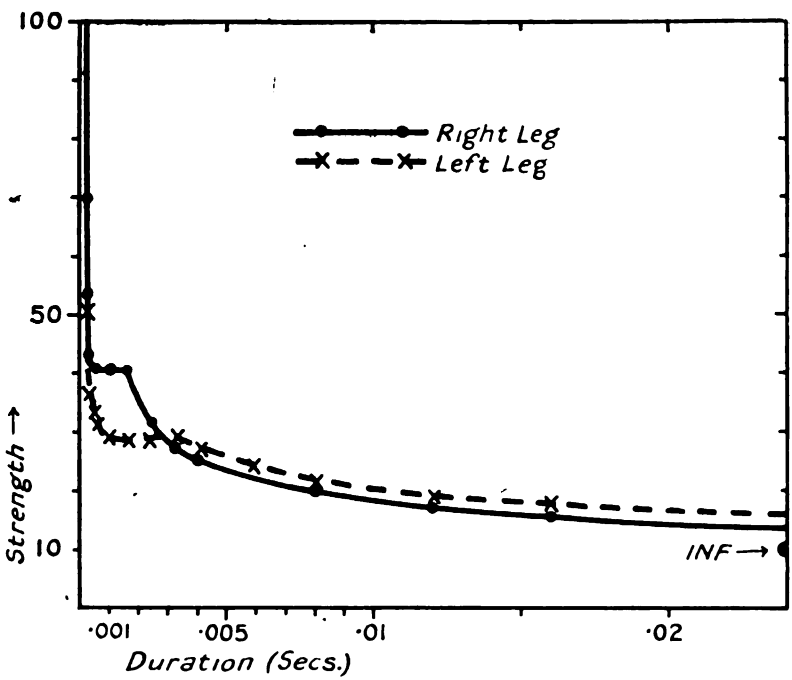

FIG. 7.

power improved more rapidly. The determinations on November 27 and December 8 are shown in figs. 6 and 7. The curve for the right tibialis anticus is drawn as an unbroken line, and that for the left is interrupted. All these curves show an obvious discontinuity, and are composed of two simple curves of the same form but different constants. In fig. 6, for instance, in the curve for the right tibialis anticus there is a discontinuity when the duration is reduced to 0·0008 second and the strength is risen to 60. At this point the curve suddenly becomes horizontal and the strength

remains constant at 60 until the duration has fallen to 0·0002 second. A further slight decrease in duration causes a sudden rise in the strength. In the curve for the left tibialis anticus the discontinuity occurs when the duration is 0·0024 second, and the strength 35, and the curve does not begin to rise steeply again until the duration has fallen to 0·00024 second.

In fig. 7 the discontinuities occur at longer durations and smaller current strengths. That for the right leg begins at a duration of 0·0016 second and a strength of 40, and that for the left at a duration of 0·0032 and a strength of 29. The curves had not changed appreciably from this at the third determination on December 26.

(*To be continued.*)

THE TREATMENT OF GUNSHOT WOUNDS OF THE SPINE.

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When considering the place in the theatre of war at which spinal injuries should receive operative treatment, it is necessary to weigh the advantages of an early operation which will limit the spread of septic infection, and relieve the central nervous system of deleterious pressure against certain disadvantages. These injuries require careful examination and in some cases prolonged observation before they are submitted to operation; a specially trained staff is required for their operative and after treatment. It is usually considered desirable that the patients should remain in the hospital in which they are operated upon for a considerable time. I think it is extremely doubtful that transport will be more injurious after an operation than before it. Of one thing I am convinced and that is that the relief from pain which follows a successful laminectomy places the patient in a much better position to withstand the strain of the journey. It is inevitable that, with the exception of certain conditions in siege warfare when special units can be organized for particular branches of surgery, the treatment of these cases will have to be relegated to the base hospitals.

The following case is not without interest from the fact that the missile was removed from a portion of the vertebræ inaccessible by laminectomy:—

Case 1.—Pte. C. was wounded by a rifle bullet which entered the right loin two inches below the extremity of the last rib and fracturing the transverse process of the second lumbar vertebra lodged to the right of the body of the same vertebra. The patient suffered from severe local pain which radiated down the branches of the lumbar plexus. There was partial motor and sensory impairment of the right leg. Five days after the injury a long incision was made in the right loin and peritoneum exposed by muscle splitting. A hand was then inserted by a retro-peritoneal route and the fractured vertebra felt for as a guide to the bullet. A scoop was passed down the same track and the bullet removed. A counter-incision was made from the back to the site of the bullet and the cavity drained by salt sac. Pain disappeared after the operation.

Fourteen days later the wounds were healed, full sensory and motor control had returned and the patient had entirely recovered.

Wounds of the spine may be extensive, the whole section of the cord being involved and conductivity of the cord lost. Such cases present all the unfavourable phenomena associated with fracture-dislocation of the spine as met with in civil practice, together with the additional danger of a septic infection. These are obviously unsuitable for operative treatment, but it is otherwise with many cases of spinal injury.

The following case by Capt. Hepburn illustrates a type of inoperable cases complicated by concomitant injuries:—

Case 2.—Wounded by a fragment of high explosive shell.

Admitted about three days later with an irregular wound which would admit two fingers, situated about two inches to the right of the second lumbar spine. The wound was very septic with extensive surrounding cellulitis. X-ray showed the shell fragment lying in front of the left margin of the second lumbar vertebra with a fracture of the body.

The patient became very toxic and extremely jaundiced with severe abdominal pain and vomiting and died ten days after being wounded.

At autopsy the shell fragment was found between the two layers of mesentery of the small bowel, which was extremely thickened. There was extensive retroperitoneal effusion of blood, a fracture of the body of the second lumbar vertebra, laceration of the top of the right kidney, but no laceration of the peritoneum and no injury of the liver.

Considering the results of spinal injuries as a whole, it must be admitted that they have not been encouraging, but it will probably be found that better results will be obtained in the future. At the present time improvement has been noticeable in the results of treatment in these injuries. The cause of disappointment in the past was partly due to a lack of differentiation between hopeless cases and cases likely to benefit by operative treatment, and partly to delay in operation. Spinal operations, to be successful, must be performed at an early stage before any vital changes have occurred in the cord. The earlier circumstances allow the cases to be operated upon the better will be the results. By delaying the operation cases lose their chance of recovery in two ways, sepsis spreads, and pressure upon the nerve tissue causes vital changes in the cord. An early operation will remove the septic focus and relieve the pressure upon the nerve tissue.

We have had many opportunities of witnessing the relief which follows the removal of a foreign body from the central nervous system. A foreign body, whether a missile or a depressed fragment of bone, exercises a striking effect upon the circulation of the brain and cord, and coincident with its removal the previously non-pulsating tissues begin to vibrate. Good circulation is essential to the recovery of injured tissue and early operation affords the best chance of relieving the interference in an injury to brain and spinal cord.

We know that by operation planned to remove septic tissue and to relieve the pressure of fragments of bone or foreign bodies we can effectively deal with depressed compound fractures of the skull, and that by adopting the same principle we can excise a penetrating wound of the knee, remove infected bone, and obtain an aseptic result. It would appear rational to apply the same principle to injuries of the spine and, with certain reservations, this can be done. The spinal injury differs from the head injury in the greater susceptibility of the spinal cord and its lack of regenerative power. The small area of the spinal cord renders an injury to the cord of much more serious importance than an injury to the brain. An injured area in the brain may recover, while an injury of corresponding size to the cord may destroy the whole section of the cord.

It would appear justifiable to operate upon spinal injuries when a foreign body is present, and has been shown by X-ray localization to be in an accessible position. Septic trouble is almost certain to follow a foreign body lodged within the spinal theca, and its removal will not add materially to the patient's danger. Severe pain alone is occasionally a sufficient reason for operating.

The principal indications which make operative interference justifiable are evidence of some conductivity of the cord evidenced by the presence of some motor and sensory function in the part below the injury. Here the transverse lesion of the cord is incomplete, and the removal of pressure may be followed by great improvement. The circulation is restored and function is recovered.

Case 3.—Serjt. W. was wounded on October 24, and admitted to a base hospital on October 26. There was a clean entrance wound at the back of the neck, two inches to the right of the spinous process of the sixth cervical vertebra, and an exit wound in front, below the margin of the lower jaw on the left side.

The symptoms present were left hemiplegia and paralysis of the right arm, loss of sensibility on the left side, and hyperæsthesia of the right arm and foot. The presence of conductivity of the cord

and the evidence of fracture of the fifth cervical vertebra were considered sufficient reason for operating.

A long incision was made over and down to the spine of the cervical vertebræ, and the spinous processes cleared of muscles. Retractors were placed in the grooves on either side of the spines, and the muscles retracted; the laminæ were exposed and the fracture of the fifth vertebra discovered. The spinous process of this vertebra was fractured and the lamina on the left side was fractured near the articular process. The spinous processes of the vertebræ above and below were cut off. The right lamina was divided and the laminæ of the damaged vertebra removed. A detached fragment of bone was found pressing upon the spinal theca. The dura was not lacerated, and pulsated normally. The depressed fragment was removed and the wound sutured. The right arm recovered rapidly, and the following day sensation was normal. The patient suffered from considerable pain in the right arm after the operation. The operation wound healed by primary union.

The patient slowly recovered the use of his limbs, and three weeks after the operation had completely recovered, with the exception of partial paralysis of the left arm.

Injuries to the cauda equina have a much more hopeful outlook. The cauda equina bears a greater resemblance to the peripheral nerves than the spinal cord, and its nerve roots have been cut and sutured in animals with complete recovery of function later. Tuffier operated upon the first two lumbar roots which had been divided by a bullet wound and obtained perfect recovery.

The principal points by which injury of the cauda equina can be differentiated from injury of the cord are: the position of the wound; X-ray may show a missile or fracture of the lower lumbar vertebræ; asymmetry of the symptoms; severe pain. Pain and hyperæsthesia are indicative of injury of nerve roots rather than cord. Abolition of the deep reflexes points to a lesion of the nerve roots, either the efferent or afferent fibres being injured. The reflex centre in the cord may be injured in some cases, but the loss of conductivity will then be complete. Limitation of symptoms to a small portion of the segments of the lumbar-sacral region denotes a caudal lesion. A rapid increase of symptoms from segment will denote a medullary lesion. A slow involvement of additional segments will point to a caudal lesion.

Three lines of treatment are indicated: Prevention of sepsis, removal of gross pressure upon the spine, and the prevention of complications which threaten life.

The most dangerous complication associated with spinal injury

is septic infection of the genito-urinary tract, and this can usually be prevented by adequate care in the passing of catheters, and by the use of urinary antiseptics and lavage of the bladder. A solution of quinine sulphate, one or two grains to the ounce, has been recommended for this purpose. It is important that a catheter should be passed when the patient arrives at or leaves a hospital, and that instructions be given for the passage of this instrument during transport. The risk of sepsis is not added to by irrigation of the bladder once it is necessary to catheterize.

The following classification of injuries may be given from the point of view of treatment :—

(1) Injuries which have not perforated the spinal theca.

(2) Concussion of the spinal cord may be produced by the passage of a bullet through the vertebræ without actual pressure of the missile or bone fragment.

A trauma of the spinal column, even of a comparatively slight nature, may be followed by an injury to the cord itself. The differentiation of a concussion from an organic injury has an important influence on treatment. A bullet passing through the body of a vertebra or merely touching one of the processes may produce a concussion of the spine almost indistinguishable from an organic lesion. Neurologists rely mainly upon the improvement of the symptoms when differentiating between the two conditions.

In severe concussion, paralysis of the body below the lesion takes place, the reflexes are lost, sensation is diminished, and the sphincters are paralysed. The chief signs by which the lesion can be differentiated from pressure upon the cord are as follows: The transient nature of the symptoms—soon after the injury the patient begins to recover, and there is a gradual return of functions. The symptoms usually correspond to those of a complete transverse lesion, and there is a complete loss of conductivity of the cord. An X-ray examination will be negative in its findings.

The careful examination of the nervous system, the observation of the cause of the symptoms together with an X-ray examination will usually differentiate cases of concussion from cases suitable for operation, and prevent an unnecessary operation being undertaken. In some cases the diagnosis will only be made in the course of an exploratory operation. In cases in which the symptoms are practically indistinguishable from gross injury, an operation would appear to be justifiable on the grounds that the operation will do no damage, and waiting will inflict irreparable damage upon cases suffering from the effects of pressure. Moreover, when a bullet has caused concussion, it has, in all probability, depressed bone also.

Pressure upon the spinal theca by missiles, depressed fragments of bone, or extradural hæmorrhage. Here the outlook is most hopeful if the operation is performed before the pressure has caused irreparable damage to the nerve tissue.

Laminectomy should be performed and the missile or depressed fragments removed.

Complete recovery occurred after the removal of a shell fragment which had fractured the laminæ of the fifth cervical vertebra, and depressed bone to the extent of half an inch square. Signs of recovery began to appear the day after the operation. The patient left for England with complete recovery of function.

Spinal hæmorrhage may be produced by indirect violence, such as fracture of the body of a vertebra by a high velocity bullet or by direct injury to the theca by a missile or bone fragment.

Extradural hæmorrhage or hæmorrhage into the spinal theca may occur, and both conditions may be present in some cases. Cases of hæmorrhage without other spinal lesions such as concussion or pressure on the theca by foreign bodies or bone are rarely seen, but hæmorrhage in a degree sufficient to cause symptoms of pressure is often present with other lesions. In one case operated upon for a bullet wound in the lower dorsal region, there was paralysis of both legs and of the sphincters; signs of conductivity of the cord were evidenced by the presence of sensation below the injury. A laminectomy was performed and a small fragment of bone discovered pressing upon the front of the cord. The dura was not lacerated and was pulsating feebly. When retracting the cord to remove the fragments of bone, a considerable amount of clot was squeezed out of the spinal canal, and at once the dura began to pulsate normally.

The treatment of spinal hæmorrhage will usually form part of the treatment undertaken for the relief of pressure from some other cause, otherwise the patient may show signs of improvement and the treatment will be expectant. Cases in which spinal hæmorrhage played an important clinical part have been rare in our experience. The optimistic view that hæmorrhage into the spinal theca will recover spontaneously is more than doubtful, and such cases would appear suitable for exploration.

Injuries to the Spine with Penetration of the Dura.

(1) The condition is comparable to that of depressed fracture of the skull, with particles of indriven bone penetrating the cranial meninges and lacerating the brain. Sepsis is exceedingly likely

to extend to the spinal meninges along the bullet tract and depressed bone. The most excruciating pain may be caused by depressed particles of bone and the advance of sepsis mercifully ends the patient's suffering by causing spinal meningitis.

The only successful treatment is the early removal of the peccant fragments. Expectant treatment allows the patient to run risks out of all proportion to the risk of an operation. If spinal sepsis does not end the patient's sufferings an infection of the genito-urinary tract usually occurs, and in those rare cases when the patient survives these dangers he often remains a hopeless paralytic inhabitant of some asylum.

Undertaken at an early stage by specially experienced operators the surgical treatment of this condition should prove, if not brilliant, at least a means of saving a fair portion of the victims.

It is of the utmost importance that the operation be carried out under a local anæsthetic, or shock, hæmorrhage, and chest complications will levy their toll. The operation begins as an ordinary laminectomy operation, except that if the bullet tract be accessible it should be excised. In some cases the results can be obtained without any bone cutting at all, the fractured lamina being merely removed with forceps and scissors.

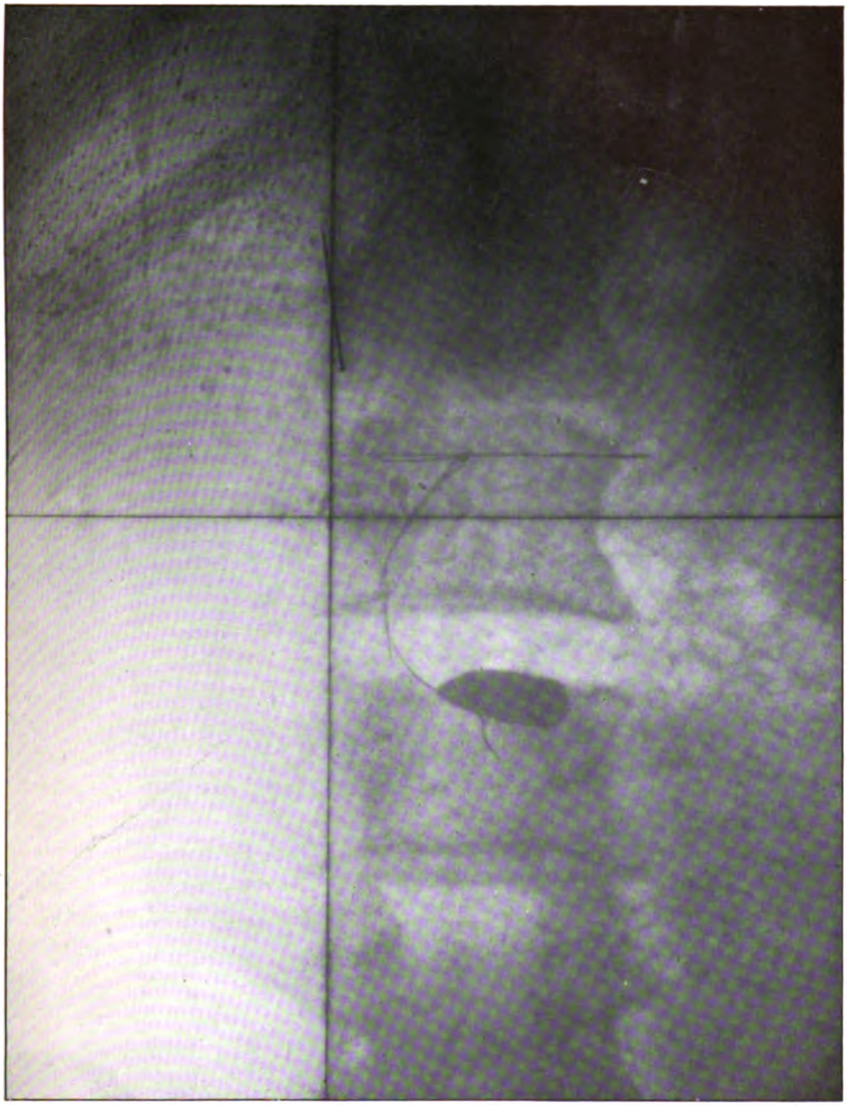
Circulatory disturbances are at work in these cases; the pressure of the fragments upon nervous tissue exercising an untoward effect upon the circulation of the central nervous system. The importance of the early relief of this interference with the circulation must be emphasized if a favourable result is to be obtained. The delicate nerve tissue of the cord rapidly receives irreparable injury from pressure, the patient is worn out by pain, and septic infection extends as a result of delay in operation. Operative treatment may be contra-indicated in some cases. Severe injury to other organs, and total loss of conductivity of the cord will usually negative operative treatment.

Foreign Bodies within the Spinal Theca.

In addition to any damage which the missile may have inflicted on the cord or cauda equina, the danger of sepsis makes the injury a most serious one. The missile will almost certainly have carried septic matter into the wound and will form a septic focus within the theca. Early removal of the missile gives the patient his only chance if the missile be septic.

The results of removing septic missiles from within the cranial

CASE 2.



The silver suture facilitates localization and finding of the missile.

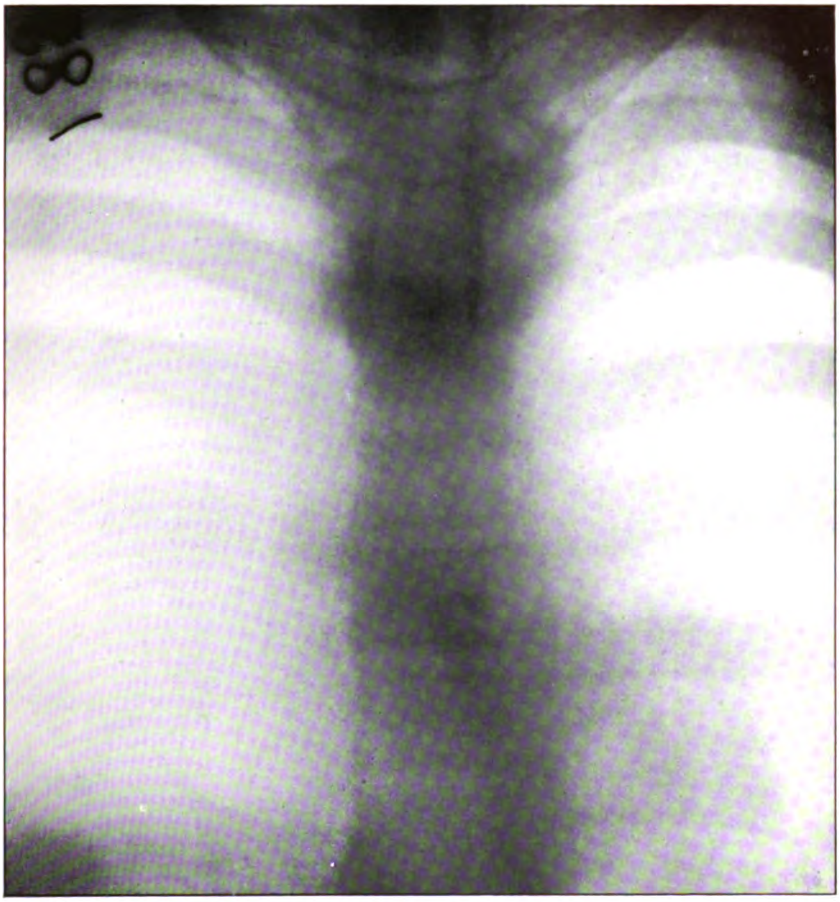
To illustrate "The Treatment of Gunshot Wounds of the Spine," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

CASE 3.

Shell wound of spine.

To illustrate "The Treatment of Gunshot Wounds of the Spine," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

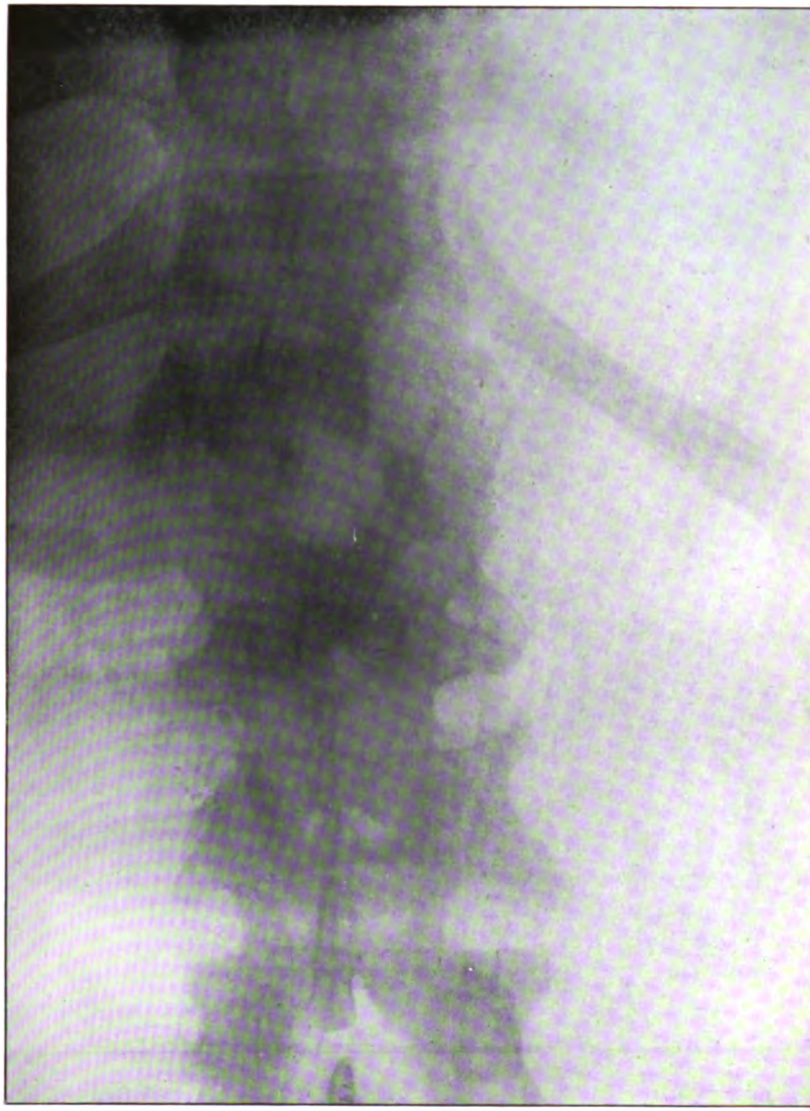
CASE 4.



Pte. M. Shell wound of spine. Foreign body removed from septic wound of the spine with recovery.

To illustrate "The Treatment of Gunshot Wounds of the Spine," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

CASE 5.



Fracture dislocation of the first and second lumbar vertebræ caused by the fall of a trench wall. Motor and sensory paralysis were complete, with the exception of slight movement in the toes of the left foot. Retention of urine: The patient suffered excruciating pain. There was little hope of improvement in function, but a laminectomy was considered justifiable for the relief of pain. The pain was immediately cured by laminectomy, and considerable improvement in motor power resulted.

To illustrate "The Treatment of Gunshot Wounds of the Spine," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

meninges is sufficiently satisfactory to make such operations on the spine hopeful if performed within a reasonable time of the injury. In one case a shrapnel bullet was removed from within the spinal theca in the lumbar region seven days after the injury. The patient was paraplegic before the operation and great improvement in motor power had taken place before he left hospital.

The interest of the following case lies in the fact that complete recovery followed an operation upon a septic wound complicated by a septic compound fracture in the vicinity of the spinal wound. The case appeared to be almost hopeless as septic meningitis seemed almost certain to occur. In this case, as in all spinal cases, urotropine was administered from the beginning.

Case 4.—Pte. M., was wounded in several places by fragments of high explosive shell. Two fragments lacerated the skin over the fifth dorsal spine, fractured the spinal laminæ and entered the spinal theca. A larger fragment inflicted a large lacerated wound over and fractured the left scapula. Partial motor and sensory paralysis of both limbs was present and the patient suffered from violent pains in the right leg. The bladder and rectum were normal. Five days after the injury the compound fracture of the scapula was in a most septic condition and pus and cerebrospinal fluid were exuding from the spinal wound. Two metallic foreign bodies were localized within the spinal canal. The septic compound fracture of the scapula was treated by dressing with gauze soaked with hypertonic salt solution, the dressing remaining in the wound, untouched, for four days. The perforating wound of the spine was excised, the track of the missile having been packed with gauze soaked with tincture of iodine. The laminæ of the fifth and sixth dorsal vertebræ were exposed, a comminuted fracture of the fifth arch was discovered, this was removed and numerous depressed fragments of bone were removed. A laceration of the dura was present, a scoop passed through the laceration detected a metallic foreign body; this missile and some fragments of bone were removed. The second fragment could not be reached, so the laminæ of the sixth dorsal vertebra were removed; the remaining fragment was then removed from the spinal theca. Two small salt sacs were inserted down to, but not into the spinal theca, and the muscles were drawn together by a catgut suture. The skin wound was partially closed. The spinal wound was well shut off from the septic compound fracture by impermeable material. The entire operation was performed under local anæsthesia.

The patient's limbs were massaged daily and ten days after the operation he had regained complete motor and sensory functions. The spinal wound was dressed seven days after the injury, the salt sac came away quite easily and the wound was afterwards dressed daily with five per cent. saline solution. A considerable amount of cerebrospinal fluid escaped from the wound for a fortnight after the operation. The patient suffered from violent pain in his legs during convalescence.

Two months after the injury, the patient was walking about completely cured.

Wounds of the Spine causing Total Loss of Conductivity of the Cord.

An irreparable injury has been inflicted upon the cord and an operation will not lead to any improvement of the symptoms. These cases are comparable to the cases of fracture dislocation of the spine met with in civil practice. They are unsuitable for operative treatment. An exception to this may be made in cases in which the pain is so severe that an operation is worth undertaking for its relief alone.

Exceptionally, it may be possible to prolong a patient's life, although he is foredoomed to death, by undertaking an operation for the removal of sepsis.

The Indications for Operation in Gunshot Wounds of the Spine.

(1) *Cases in which there is Evidence of some Conductivity of the Spine.*—In all cases in which conductivity of the spine remains there is hope of improvement in the functions. An operation will not harm the cases in which the damage to the cord is too extensive to allow of recovery, and will save the lives and functions of the slighter cases.

Pain.—The pain in some spinal lesions is so atrocious that an operation is justifiable whatever the lesion of the cord.

Case 5.—Fracture dislocation of the first and second lumbar vertebræ caused by the fall of a trench wall. Motor and sensory paralysis were complete with the exception of slight movement in the toes of the left foot. Retention of urine. The patient suffered excruciating pain. There was little hope of improvement in function, but a laminectomy was considered justifiable for the relief of pain. The pain was immediately cured by laminectomy and considerable improvement in motor power resulted.

Operations upon Spinal Injuries.—The X-ray examination preceding the operation is of the greatest importance. A lateral as well as an antero-posterior plate is always necessary, and if a foreign body is present accurate localization must be carried out. The localization of the foreign body is so important and so difficult to obtain in this situation that special precautions must be taken. No reliance should be placed upon stereoscopic plates when used either in a stereoscope or by squinting. They are liable to represent a foreign body either deep or superficial to a known structure according to the preconceived idea of the observer. In the lumbar region the curve of the spine prevents the close application of a glass plate to the skin ; a film should be employed in this situation. It is necessary to place beyond all possible doubt the level at which a foreign body lies. The surgeon must be able to attack the lamina concealing the foreign body with confidence that he is removing the right one. Unnecessary removal of the lamina and dangerous searching will be avoided if the following procedure be adopted :—

Under local anæsthesia a deep silver suture is placed at the side of the spinous process of the suspected vertebræ. The patient is then X-rayed and the wire left in situ. During the operation, whether the wire is next to the vertebra concealing the missile or not, it will be easy to identify the correct one, which if not opposite the wire is usually the one above or below (see Plate IV). A similar method is to scratch the skin across the suspected spinous process and lay a needle across the scratch before taking the X-ray plate. Some such precaution is to be recommended. Counting the vertebræ during an operation has caused doubt and difficulty even to experienced operators.

Shaving the skin area, cleansing with ether and biniodide, the application of a sterile dressing two hours before the operation, and painting the skin with iodine at the time of operation has given satisfactory results. Local anæsthesia has usually been employed, in some cases combined with a slight degree of ether or chloroform anæsthesia. The use of a local anæsthesia has been found to be so advantageous that other methods have been abandoned. The success of the operation depends largely upon its use. Several cases suffering from severe chest complications have had no ill-effect from the operation. Either the prone or the lateral position may be employed; the prone position gives the better exposure of the vertebræ. When the lateral position is employed the lower leg is placed in the extended position, the upper leg is flexed, the knee being bent to a right angle, and

a thick hard pillow is placed beneath the bent knee and leg. In this position the patient rests comfortably and firmly on his side. An incision is made in the middle line down to the spinous process. The incision should be a long one, about eight inches in length. The retraction of the soft part and exposure of the laminæ are much facilitated by a long incision, and the whole operation can be carried out with greater ease. The spinous processes are then cleared on both sides by cutting downwards close to the spinous process to the laminæ through the whole length of the incision. With a pair of strong scissors the remaining muscles attached to the spinous processes are cut and cleared away. When the soft parts have been cleared from the spinous processes throughout the whole length of the wound, it will be possible to pass a pair of retractors down to the laminæ in the grooves on either side of the spine and retract the erector spinæ muscles.

The vertebræ can now be examined; if a depressed fractured lamina is discovered the spines of the fractured vertebra above and below are cut off and the fracture examined. In some cases the fracture involves the laminæ at each side, and these can be removed when the ligamenta subflava have been divided.

The lamina of one side may be fractured and it may only be necessary to divide the uninjured side, or both laminæ being fractured they can be removed without cutting any bone.

The most difficult step in the operation is the division of the first lamina. The lamina must be removed as far as the articular process, but it is not necessary to commence the section at this difficult spot; the lamina may be divided nearer to the spinous process and the remainder of the lamina removed with bone forceps. There are three well-known methods of dividing the laminæ, of which the use of the cutting bone forceps is probably the easiest and most convenient. A saw may be used, either of the guarded pattern or a Hey's skull saw. The cut is made with an inward direction in order to avoid the articular process and the section is completed with forceps. The drilling or trephining method is carried out by cutting a hole in the middle of the lamina with a drill or burr and completing the section with De Vilbiss or other suitable forceps. The entire division by forceps is rapid and sufficiently easy. Laminectomy forceps, Sargent's craniectomy forceps, or Johnson's bone forceps may be used. Whatever forceps are employed, the surgeon must be practised in the use of the instrument. With well devised bone forceps the lamina may be

bevelled until the edge is very thin and easily elevated. The spinal dura is separated from the lamina by tissue, and is not easily injured with ordinary care. The infiltration of the tissue with adrenalin solution, a long incision permitting easy retraction and a good exposure of the laminæ, will greatly facilitate this difficult stage of the operation.

When the spinal canal is opened the condition of the fracture can be further investigated, detached fragments of bone or the missile may be discovered. The spinal canal will sometimes be found to be filled with effused blood, and a continuous stream of saline may be commenced at this stage. The dura is examined, and if uninjured and pulsating normally is not opened. If lacerations are present, depressed fragments of bone or missiles are sought for.

In the dorsal area it is comparatively easy to explore the spinal canal anterior to the cord. One or two nerve roots may be divided with safety in this region and the theca gently contracted. The nerve roots are afterwards sutured with fine catgut. Operations for injury to the cauda equina have given best results in this region. Any division of the cauda which is discovered should be sutured. The probability of regeneration and recovery of function is considerable. The operation is completed by suturing the spinal muscles by one continuous catgut suture and suturing the skin without drainage. The wound is invariably painted with mastisol wound varnish. Secondary infection and death from meningitis is very apt to follow drained laminectomy wounds when incontinence of urine or fæces is present.

At the conclusion of the operation and for some days afterwards, the patient is placed flat on his back. The pressure upon the wound is advantageous.

In conclusion—(1) The majority of cases of gunshot injury to the spine require excision of the wound and exploration at the earliest favourable opportunity.

(2) The diagnosis is not so gloomy as past experience teaches.

(3) Local anæsthesia is practically essential.

(4) The administration of urotropine should be begun as soon after the injury as possible.

(5) The presence of a missile together with severe pain are indications for immediate operation.

(6) Accurate localization of foreign bodies is of the utmost moment. A lateral as well as an anterior posterior view is desirable.

Clinical and other Notes.

A CASE OF BILATERAL MOTOR APRAXIA WITH DISTURBANCE OF VISUAL ORIENTATION.

By Temporary-Captain S. SMITH, M.B., B.S.Lond.

and

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Royal Army Medical Corps.

It has been only within the last few years that the motor disturbance known as apraxia has claimed much attention, or been fully investigated, and even yet very few well marked instances of the condition have been described in English literature; in fact it is mainly through the careful summary of the work of continental authors published seven years ago by Dr. S. A. K. Wilson that apraxia is known to English readers.

Apraxia is a complicated condition, but in its simplest terms it consists in inability to combine simple movements into complete purposive acts; in other words, it is a condition in which a patient, in whom the power of voluntary movement is intact, or, at least, not seriously affected by palsy, ataxia, or sensory loss, is yet unable to perform certain actions, or is incapable of employing objects—as a knife or key—correctly, even though he is aware of what is required of him, and though he recognizes the use and the nature of the object. Liepmann, to whom our knowledge of the condition is largely due, has defined motor apraxia as incapacity for subjectively purposive movements of the limbs, with conservation of the power of movement.

Apraxia may be of different degrees of severity, and may affect the limbs of one only or of both sides; its only manifestation may be the inability to protrude the tongue, to which Hughlings Jackson originally drew attention in hemiplegic patients, or the patient may fail in most actions he is requested to attempt. Usually, however, he succeeds in some acts and fails in others, as a rule in the most complicated and less familiar.

Many factors may contribute to this complex functional disturbance, especially mental impairment, with affection of memory and attention, sensory loss, and agnosia, or inability to recognize objects; but in the case described here the intellectual state was moderately good, there was no affection of sensation, and no form of agnosia. Vision, it is true, was affected, but its disturbance obviously stood in no causal relation to the apraxia.

The patient, Pte. M., aged 27, was admitted to a base hospital on November 2, 1914, with the history of having been wounded in the head

by a shrapnel bullet some days previously. On admission, he was in a dull and confused state; he was unable to remember his number or regiment, how he was wounded, and what happened to him during the several days that elapsed between the infliction of the wound and his arrival at the base. There was no paralysis, and the range and the power of the movements of all his limbs were normal; there was no obvious ataxia. The right knee-jerk was, however, brisker than the left, and the plantar response on this side was extensor. Tactile and painful stimuli were appreciated naturally, and localized correctly everywhere, and there was apparently no loss in his sense of position. There was no optic neuritis.

The *wound of entry* was a small puncture 23 centimetres behind the nasion (nasion to inion = 34 centimetres), and 7 centimetres to the right of the middle line; there was no exit wound, but a round shrapnel bullet could be felt under the scalp 4 centimetres above and 4 centimetres behind the upper margin of the attachment of the left pinna. An X-ray examination revealed a small gap in the skull under the wound of entry, and several fragments of bone deep in the brain substance along a track leading from it. The bullet had apparently just broken through the skull in the left temporal region, and was removed from here together with several fragments of bone by Lieutenant-Colonel Sargent a few days later. It was a spherical lead ball, twelve millimetres in diameter. It was dropped into sterile broth, but produced no growth. A clean circular opening only slightly larger than the missile was found in the squamous bone. The entrance wound was not touched till several weeks later, when a few fragments of bone, which had been probably extruded from the brain, were removed from dense fibrous tissue at the bottom of a shallow sinus.

His condition improved rapidly after his admission to hospital; no weakness or paralysis developed, his reflexes became normal, and all forms of sensation remained unaffected. His hearing was also normal but there was a complicated disturbance of vision which will be described in detail later. He rapidly regained almost the entire use of his intellectual faculties; he had been apparently an intelligent man, had been educated at a first class school and trained as an engineer; before enlistment he was employed as a draughtsman. His memory for the past was evidently fair, but there was a blank which gradually diminished for events that occurred during a considerable period before the infliction of the wound. On the other hand, his retentiveness, especially to visual impressions, was much impaired. His general attention was always fair, though at first he tended to tire easily; at no time, however, during the three months he was under observation could his behaviour and conduct be described as normal: it rather resembled that of an intelligent child, and he was in fact always treated by his fellow-patients and by the nurses as an interesting child would be. He was always too facile,

laughed unnecessarily and often inappropriately, and on one occasion when another patient near him died he burst into tears and asked to be moved into another ward. He was always extremely good-tempered and never moodish. One striking feature was the fact that he rarely showed any signs of irritation or natural annoyance when he failed to perform simple actions on request or spontaneously.

There was a considerable disturbance of speech when he was first admitted but it became gradually less; in the first place he stuttered, but according to his own statement he was subject to this in childhood, and apart from this he had no obvious difficulty in uttering words. He could understand speech and even complicated orders fully, or failed to do so only when his power of retaining the whole sentence was at fault. He always comprehended, for instance, and reacted intelligently to any joke made at his bedside. He had, however, some difficulty in calling up words, especially names, but even then succeeded in expressing himself fully by the substitution of a word or of an explanatory phrase. He never used wrong words.

He was from the first able to read and comprehend short sentences, but had great difficulty in following consecutive words and lines owing to his visual trouble; during the whole time he was under observation he had, however, considerable difficulty in reading individual letters aloud. He was quite unable to write even single letters, and on attempting it only made an unintelligible scrawl, most often a rough circle, but as he was equally incapable of drawing a line or any simple object, although he was a draughtsman by profession, this inability was obviously due to his apraxia rather than to a specific agraphia. Between two and three months after the infliction of the wound, when most of these observations were recorded, his speech defect was almost negligible.

In spite of the fact that there was no weakness, ataxia or sensory disturbance in any of his limbs he showed from the first day he was in hospital a peculiar motor disability which consisted essentially in an inability to perform certain, even simple purposive, actions and to use objects and instruments which were quite familiar to him and which he recognized correctly. At first, for instance, he had even difficulty in feeding himself, in performing movements to order and in using even the simplest tools, as a pencil or knife, but with time this inability gradually diminished, apparently largely owing to constant practice and steady application—for he certainly re-learned first those actions of which he had most need, as lighting a cigarette.

The nature of this disability can be most easily conveyed by describing his attempts to execute actions of various kinds; here, however, it is advisable to emphasize again that he always had a clear idea of what he was required to do, and that he never showed any signs of agnosia, or inability to recognize the use and nature of objects which he perceived either by vision or by touch. Further, he was never satisfied with the

execution of a wrong action or with the misuse of an instrument, as a patient with aphasia, agnosia or general mental impairment may be. On the other hand, he was always anxious to explain his mistakes and failures, generally saying "I have forgotten how to do it," or "That is something like what you wanted me to do, but it is not quite right, I can't remember exactly."

An attempt to analyse his difficulties by further introspection yielded no reliable facts.

The motor disability was equally pronounced in his two hands, and involved the movements of his legs too; it was usually more prominent when the action required the use of two hands than in those which he could perform with one alone; when given, for instance, a knife and fork he always focused his attention on, and directed his efforts to the one first, and only after he was satisfied with the result attempted to grasp the other or use it appropriately. His disability could be excellently illustrated by handing him a pencil and asking him to draw a line, any simple object, or form a letter; at first he had great difficulty in taking hold of the pencil correctly and when he succeeded, or after he had learned to do so, he would bring its point slowly to the paper and then hesitate as though perplexed as to how to use it. If urged to complete the drawing or letter he would suddenly make an irregular scrawl, which frequently resembled an O or C, and if then asked what he had drawn would smile and remark, "No, that's not what I wanted to do, that is like an O (or C)." The result was the same whether he was asked to write a letter or draw a straight line or a pipe, yet he always recognized these figures when drawn and shown to him; on one occasion when he had formed a circle in his attempt to sketch a pipe he pointed out that it was like the opening of the bowl of the pipe, but it was not what he intended to draw. He succeeded no better in his attempts to copy simple linear figures.

The following tables illustrate his efforts to perform certain actions about two months after the infliction of the wound; the actions required of him are given in the left columns, his attempts to execute them in the right.

(1) ACTIONS TO ORDER.

(*a*) Put out your tongue.	Well performed (formerly unable to do this, showed teeth and grinned when this order given).
(*b*) Cough.	Well performed.
(*c*) Smell.	No movement at first, succeeds when piece of soap put in front of him, when this is removed fails.
(*d*) Yawn.	Opens mouth, makes whistling movements.
(*e*) Whistle.	Opens mouth, puts out tongue.
(*f*) Put right hand on top of head.	At first brings hand to chin, then to nose, then holds in front of him, says "This is my right hand," slowly brings to top of head.
(*g*) Put left hand on top of head.	Identical with last.

(*h*) Put right thumb into mouth.	Identifies thumb, then puts forefinger into mouth, recognizes mistake, says "No, that's my thumb," holding thumb with left hand, eventually puts left thumb into mouth.
(*i*) Turn eyes to right.	Looks straight in front of him, looks first to left, and finally turns eyes to right.
(*j*) Eyes right (uttered sharply as a military order).	Well and quickly performed (at first had no more success with this than last order).
(*k*) Salute.	Brings hand smartly to forehead giving correct military salute (has been able to perform this military act almost from the day of admission).

(2) Ability to Recognize and Use Various Objects when shown them.

(*a*) Shown a key.	Names correctly, describes use "to put in lock," fumbles with key for nearly a minute, holds in many attitudes, then, holding by ring, at last makes correct movement with hand.
(*b*) Use of knife and fork.	Fails to get either knife or fork correctly into hand, grasps in various positions, first puts fork in left hand and knife in right, then changes about, even when they are placed correctly in hands fails to make correct movements.
(*c*) Unbutton coat.	Slow and clumsy, but succeeds, tendency to "tear out" button.
(*d*) Button coat.	Correct with right and left hands.
(*e*) Shuffle a pack of cards.	Takes hold of cards aimlessly, one or two at a time, makes no attempt to shuffle.
(*f*) "Shoulder arms" when given piece of wood to represent rifle.	Takes "rifle" first in one hand then in the other, holds against right shoulder then left, performing various movements, all incorrect, with unengaged hand, makes no intelligent attempt even when shown correct method by observer.
(*g*) Given a book upside down, told to read from it.	Says "Oh, this is upside down," endeavours to rectify error, turns over pages, holds book on end, looks along it, fumbles with pages, says "No, I can't do it." When book put right way up by observer, and given him, says, "Yes, that's right," and proceeds to read.
(*h*) Open matchbox and remove three matches.	This correctly performed after some fumbling and hesitation. (He was quite unable to do this for some days after admission, but being an ardent smoker has since had plenty of practice.)
(*i*) Light cigarette in his own mouth with one of the matches.	Some difficulty in finding which is right portion of box to strike on, first strikes wrong end of match, commences by lighting cigarette at about its middle, then very nearly lights his moustache, finally succeeds, puffs away contentedly.

(*j*) Replace unlighted matches in box.	Experiences much difficulty, first attempts to stuff them into unopened box, then opens box holding it upside down, at last finds interior of box and replaces matches in a very clumsy fashion.

(3) Representation of Use of Objects (without being shown them).

(*a*) Movement of key in lock.	Performs well, rotates hand correctly.
(*b*) Shake hands.	Holds right hand out, fingers extended, rotates arm (as for turning key in lock).
(*c*) Given a bowl, make movement of eating from it, with an imaginary spoon.	Quite unable to perform. (Succeeds if given a spoon with bowl.)
(*d*) Make movement of brushing teeth.	Catches hold of chin, then says "No, I had an idea, but I have lost it." Makes various incorrect attempts and says, "No, it's no use."
(*e*) Make movement of turning handle of a barrel organ.	Holds out right hand as in (*b*), rotates (again as for turning key in lock).
(*f*) Make movements of washing hands.	Succeeds only if a piece of soap and water in a basin are given him.

(4) Imitation of Movements made by Observer.

(*a*) Make a fist.	Correct right and left hands.
(*b*) Hold hands in prayer attitude.	Brings right hand to right side of face, says "No, that's wrong"; recognizes attitude when shown him by observer, says, "Yes, it's in the picture you see everywhere," then performs correctly.
(*b*) Repeated.	Caught hold of chin, then held both hands in front of him, saying, "I thought I was going to do it."
(*c*) Hold piece of wood horizontally with either hand.	Takes object, fumbles with it for a time, then places it vertically; unsatisfied with this position and eventually gives up the attempt.
(*d*) Catch nose with hands, first right, then left.	Correct.
(*e*) Put right finger in ear.	Hesitates, first puts hand on top of head, then correct.

(5) Performance of various Expressional Movements.

(*a*) Smiling, looking cross, looking sad, surprised, &c.	Normally performed, both to order and also in reaction to surrounding.

(6) Conventional Actions and Activities of Ordinary Life.

(*a*) "Throw a kiss."	Correct.
(*b*) Beckon.	Waves whole hand in an indefinite manner, says "No, that's wrong, I can't get it right."

(c) Dressing. Fails completely to put on pyjama jacket, likewise fails with trousers, putting both legs into one trouser-leg, unable to extricate himself without assistance, although he makes violent efforts.

(7) PERFORMANCE OF CERTAIN REFLEXIVE MOVEMENTS.

(*a*) When ear is tickled with a feather patient puts up hand to remove the stimulus automatically, though when ordered to put finger in ear, is unable to do so.

(*b*) If a hair is pulled or if he is pinched he brings his other hand readily to the spot stimulated, and withdraws part stimulated.

LOWER LIMBS.

When his lower limbs were investigated a condition very similar to that which affected his arms was found, that is, he had difficulty in performing purposive actions to order, imitating those made by the observer, and in employing his legs in more complex acts, as in putting on his trousers. When told to bring his right heel to his left knee, for instance, he merely crossed his feet, and when asked to put on a sock was unable to do so, not only because of the apraxia of his arms, but mainly because he failed to hold his foot in a proper position. Similarly on one occasion when, after walking about the ward he was told to sit on his bed he placed his hands on it, then turned his back in the opposite direction, and after some hesitancy began to sit down in this direction.

REMARKS.

These descriptions give an idea of his condition as it was about two months after the infliction of the wound. During the following month a certain amount of improvement occurred, especially in performance of actions in which he had had practice—as in getting his smoking materials together and lighting a cigarette. Further, it was found that he could be taught by daily practice to perform actions in which he could not at first succeed, he became able to turn a book which was given to him upside down into the correct position when he was made to do so several days in succession.

The tests recorded above show that there was no tendency to misuse or mistake objects, and no trace of agnosia; further, it is evident that he was never satisfied with his mistakes or with one action when another was required of him. Although he frequently explained his failures by saying, " I have forgotten how to do it," it was evident that they were not due to lack of attention or loss of memory, for his general attention was always fairly good, and apart from a deficient retentiveness of visual impressions, his memory was not seriously impaired.

There was at no time any trace of tonic perseveration, or difficulty in relaxing muscles that he had contracted voluntarily, which has been

often associated with apraxia, and it was only in the early stages of his illness that he showed any tendency to repeat actions which he had just performed when requested to do something else (clonic perseveration).

Visual Disturbance.

When the patient first came under observation a disturbance of vision was noticed, but its nature could not be properly investigated till his general condition had improved. The most striking feature was his difficulty in looking straight at the observer's face or at any object held in front of him; when asked to do so he generally stared open-eyed in a wrong direction and then moved his eyes about in an irregular manner, most commonly towards the ceiling, saying, "Sometimes I can see quite well, but often I cannot see what I want to look at"; on the whole he seemed to see better the less effort he made. Further, even when he could see and recognize an object he usually failed to take hold of it directly.

At present, three months after the infliction of the wound, these troubles persist, though they are less pronounced than they were. His optic discs are normal, his central vision is now $\frac{6}{6}$ in each eye, and he can recognize the movement of fingers in all parts of each half of his visual fields. Perimetric examination is not easy owing to his difficulty in keeping his eye directed on the fixation point, but repeated observations have shown he can recognize a white object ten millimetres square to the normal peripheral limits in both eyes. There is, however, some amblyopia in both lower right quadrants, which reaches to within ten degrees of the fixation point. In this amblyopic area he frequently says, "There is something moving, but it is not plain, and I don't know where it actually is." No defect in visual acuity can be discovered in the left halves of the visual fields and the fields for red and green are normal in extent to both sides of the fixation point.

Although there was no ocular palsy, for several weeks after his injury he was frequently unable to move his eyes to order in any given direction even though he understood fully what was required of him, and still he often makes mistakes, or succeeds only after several attempts; when on one occasion he was asked to look upward toward the ceiling as he was sitting erect he pointed correctly to it with his hand, but moved his eyes first to the right, then to the left and finally downwards. His eyes are, however, always turned accurately towards an unexpected noise made to one side of him, and he generally succeeds in obeying the military command of "eyes right" or "eyes left" when either is *suddenly* given to him.

He is still unable to follow accurately with his eyes a finger or any other object moved in any direction; they generally remain for a moment directed towards the position in which he originally fixed it, and may either fail to follow it at all, or they may be later suddenly jerked towards

the direction in which it was moved. Similarly he fails to keep his eyes fixed on a spot, as on the observer's eyes, when his head is passively rotated to either side.

The difficulty in fixing or bringing into central vision objects in front of him is passing off, but he frequently fails still to look directly into the observer's eyes, or at any object when asked to do so; often he merely opens his eyes, stares in a wrong direction and then swings his eyes irregularly about in search of it. Even when there can be no doubt that he knows the position of the object in space at which he should look, as his own hand, for instance, he often fails to bring his eyes directly to it. The tendency for his eyes to deviate from the object he has fixed, is now less than it was.

Further, there is frequently no reflex blinking, withdrawal of the head or other general reaction when a hand or other object is suddenly swung towards his eyes, either from in front or from either side, or to any other threatening action on the part of the observer. And when a light is suddenly turned on to one side he does not as a rule turn his eyes to it with the accuracy and promptitude of a normal person.

He still does not succeed in taking hold of an object held in front of him and in his line of vision with precision and accuracy. This defect is more clearly seen when he is asked to touch a spot on which his eyes are directed; several records were taken by asking him to bring his fingers to a black dot on a sheet of paper held in various planes of space in front of him, and it was found that the error was equally great in all directions. This defect cannot be attributed to ataxia of his limbs, that is to disharmony in the range and time of the components of the movements, as there was no evidence of this as he handles or attempts to use objects, nor can it be wholly due to the motor disability described above, as he can bring his finger accurately to the tip of his nose even when his eyes are closed. Further, there is no demonstrable loss in the sense of position or of passive movement to which "sensory ataxia" could be due. Despite the inaccuracy and awkwardness of his movements he can, however, always succeed in reaching any object which is at the moment in central vision. On one occasion, when he was not aware he was under observation he wished to get a box of matches from his locker in order to light a cigarette; he sat up in bed turned his head and eyes towards the locker, stared vacantly at one spot for a moment, then slowly and deliberately moved his eyes into other directions, until after several seconds the match box came into his central vision; then he put his hand out to take hold of it, but did not succeed in doing so accurately on the first attempt.

He does not present any trace of visual agnosia, i.e., an inability to recognize and distinguish by their visible characters objects he can see. From the first too, he recognized ordinary symbols, as the plus, subtraction and the multiplication signs, an arrow pointing to direction, etc. That he

can recognize letters and read has been already pointed out. Further, he recognized at once the well-known visual illusion of the truncated pyramid, saying, "That's a box, it changes according as your eyes catch it, sometimes I can see it open, sometimes the other way."

His visual memory too is at least not seriously affected; he can from memory describe the form of familiar objects, as a pipe, give a minute description of his father, and tell how he would reach his bedroom at home. He is evidently a strong visualist and speaks of having "a good picture" of incidents which occurred while he was in the trenches, as of a German attack by fire. His colour memory is apparently also intact; he can remember the colours of the football shirts worn by a local team and describes the sky as "blue as a rule with clouds of different colour, and it is often red at sunset especially in stormy weather."

On the other hand his visual retentiveness is very defective; when he is shown in succession four objects which he can recognize and name, he is, as a rule, unable to name them again or describe them in correct order after an interval of thirty seconds, and after the same period he is unable to recollect the number or arrangement of four or five dots which he had seen on a sheet of paper. He is much more retentive to auditory impressions, as words or sentences repeated to him.

Another prominent symptom is his inability to localize, or at least recognize correctly, the relative positions of objects placed in front of him. He has always been much confused as to which is right or left, and even after daily testing he has remained uncertain which is his right and which his left hand; his difficulty in describing whether one object is to the right or to the left of another is consequently not surprising, but it was found that when he looked at two objects he was uncertain whether two similar objects which were immediately uncovered were in the same relative positions, or if their positions had been changed when he closed his eyes for a moment. This held whether the test objects were side by side, one above the other, or one nearer. (These tests were carried out by silver and copper coins of the same size, and by squares of green and white paper.) The most remarkable errors were made when he was asked to say which of two objects was the nearer to him; even when they were separated by ten to fifteen centimetres, at a distance of half a meter from his eyes he made many mistakes; the explanation he offered spontaneously was "I can only look at one at a time"; when his finger was moved from one to the other he could, however, recognize their relative positions at once.

Similarly he often fails to distinguish the difference in length of two lines, even when it is considerable, and frequently calls the shorter the longer, or vice versa, though their lengths may be in the proportion of two to three. This is especially so when they are not drawn parallel and close to one another. An attempt was made to determine whether this failure is dependent on a defect in the execution of, or on a disturbance of

the proprioceptive impulses initiated by his ocular movements by comparing his replies when he was allowed to look at the lines for some time and range his central vision over them, with those he gave when the lines were exposed for only a moment, but his difficulty in fixation made reliable conclusions impossible. But though he is unable to estimate the relative lengths of two lines he can always recognize accurately and without delay whether a rectangular quadrilateral figure is a square or not; this is apparently due to the fact that he sees the figure as a whole and recognizes its shape at once, as he can a drawing or an illustration, while to compare the lengths of two lines he must move his eyes from one to the other.

When an object is held up to one side of the point he is at the moment fixing, he always fails to take hold of it, or even point in its direction if he does not look at it directly; if, for instance, the observer's arms are outstretched from his side, and the patient is asked to point to the moving fingers of one or other hand, he usually only brings his own hand to the observer's face or shoulder. As there is neither ataxia or serious sensory disturbance in his arms, this failure can be due only to his inability to orientate and localize correctly objects in the extra-central portions of his fields of vision, in fact he states not infrequently that though he can see the object he is not sure where it is. This was clearly demonstrated during examination with the perimeter, for he frequently said he was only aware that something white was moving somewhere, as the test object was brought towards the fixation point, and frequently made gross errors when he attempted to point to or describe its position; on one occasion, for instance, he described it in the left lower quadrant, when the object was in the right upper quadrant.

There is, obviously, then, a loss of the local signature of visual impressions, analogous to that loss which, as a result of cerebral lesions, often leads to disturbance in the localization of cutaneous stimuli.

He frequently fails to recognize moving objects by extra central vision, in portions of the visual fields in which he is certainly not blind, especially when two are presented simultaneously to him, one to each side of the fixation point, as the observer's fingers for instance. The proportion of such stimuli which he misses is variable, and increases as he tires or when his attention flags. A similar inability to recognize with the constancy that a normal person can, the presence of objects outside central vision is occasionally seen as a one-sided phenomenon with lesions of the post-central portion of the opposite cerebral hemisphere.

That objects outside the central vision do not readily excite attention is seen in many other tests too. When asked to read, for instance, he was at first frequently satisfied to pick out a few individual words from a page, and he still has difficulty in following the lines in the normal manner. Now he occasionally takes up the daily paper and can read intelligently, though only slowly and with difficulty, which is due,

he explains, to the fact, "I start to read a column but soon slip some lines, or I may get on to another column." It is remarkable that even when only one of a row of letters which he was asked to read was exposed to him, he frequently failed to fix it, saying, "I'm not looking at it now, I have lost it"—and that immediately afterwards he read correctly and with scarcely any hesitation the following title which contained words unfamiliar to him, "Histological and Experimental Observations on the Destruction of Tumour Cells in the Blood Vessels." He also makes very poor attempts at exploring with his eyes any large surface presented to him; if, for instance, he is shown the page of a journal on which there are a few widely separated illustrations he often says there is only the one on which his eyes first fall and rarely succeeds in detecting them all. Similarly when he is asked to count or to point to four or five coins placed irregularly and at some distance apart on a board in front of him he is generally content with indicating one or two and makes no attempt to run his eyes over the whole surface to make sure that those only are present which he had seen on the first glance. This failure is obviously not due only to the right-sided hemiamblyopia, for he fails as often to pick out objects to the left as to the right of the point to which his eyes are directed; it seems, in fact, that his attention to visual impressions tends to be arrested or occupied by any object that is at the moment in central vision. If, on the other hand, he is asked to count coins or other objects arranged in a close series in front of him, he usually starts at any part of the series to count to right or left, but soon becomes confused and begins to enumerate again those which he had already included in his count; he can, however, count them accurately if he is allowed to take each in succession into his hand. Similarly, though he often fails to count by vision alone fingers held at some distance apart in front of him, he succeeds if he is allowed to run his hand over them.

These and other tests indicate that not only do objects outside central vision fail to excite his attention although he is not blind to them, but that he is also unable to orientate or localize in space the positions of objects seen in the peripheral parts of the retina, and the relative positions of those that come in succession into central vision.

This case consequently presents an apraxia of the oculomotor movements similar to that described in the limbs, a defect in visual localization and orientation, and a failure of objects that stimulate the peripheral parts of the retinæ to excite attention and the appropriate ocular movements.

Although his lower limbs are apraxic in imitating movements made in front of him, in attempting movements to order, and especially in more complex actions, as in putting on his trousers, he can now walk easily, but proceeds only in short shuffling steps as though not confident of himself. His gait is, however, not ataxic. If left alone he quickly deviates from the direction in which he wishes to go and runs into objects even though he is aware they are present. When, for instance, he is asked to walk

between two rows of beds he frequently turns to the right or to the left and walks up against one; it is noteworthy that he more commonly deviates to the left, though the left halves of his visual fields are certainly unrestricted. Even when urged to keep his eyes to the ground and avoid obstacles he often does not succeed; he has even run up against a wall or against a large screen which stands in the ward. He can, however, walk straight to a person or an object some distance away if urged to keep his eyes fixed on it, provided there are no obstacles in the way.

When he was brought into a large room in which a few chairs had been placed and ordered to walk to a point which could be reached without encountering any serious obstacle, he almost invariably walked into a chair and then pulled up suddenly as if surprised at its presence, even though he had seen it and pointed to it before he started. After hesitating for a moment, as though uncertain how to get round it, he usually shuffled towards one side with sidesteps, very much as a crab does when it meets a stone, frequently retraced his steps when almost around it, and after he had evaded it often set out in a wrong direction towards his goal. He explains his difficulty by saying "I don't look where I am going and I can't always go where I want to," but if his movements are carefully observed it is obvious that it is chiefly due to the fact that visual impressions of the obstacles do not readily excite his attention.

An equally striking phenomenon is his inability, or at least his great difficulty in finding his way about. When he is taken some distance from his bed he is unable to make his way to it again even though he may see it and point correctly to it. On one occasion, for instance, he was brought about five yards from his bed, to reach which he had only to take a single right-angle turn, but though he indicated it correctly and recognized the patient in the adjoining bed, he turned to walk in a wrong direction when told to go to it. This happened even after the correct route had been pointed out to him. On another occasion, when taken into the next ward he failed to return through the open door when asked to do so.

Although inattention to visual impressions certainly contributes to it, this inability to find his way about must be attributed chiefly to loss of spatial orientation, and to inappreciation of direction and of the spatial relations of objects which he can see and recognize by vision.

Site of the Lesion.

The exact extent and position of the anatomical lesion which produced these symptoms is naturally of great interest. It may be assumed with considerable probability that the shrapnel ball had taken a direct course between its entrance and its exit, for in other cases of similar nature we found this to be the case.

Taking the points corresponding with entrance and exit wounds in the

case of Pte. M. the brain was entered in the posterior and upper part of the right supramarginal gyrus, and we have reason to believe that the track passed through the dorsal part of this hemisphere, perforated the falx 1½ millimetres dorsal to one millimetre in the front of the posterior margin of the splenium of the corpus callosum, entered the left hemisphere in this position, passed just dorsal to Wernicke's field in front of the knee of the optic radiations, and made its exit in the inferior part of the left supramarginal gyrus in front of the posterior end of the Sylvian fissure; or it is possible that at the point of exit the posterior and upper part of the second left temporal convolution was involved and that in this hemisphere it passed through the posterior horn of the lateral ventricle and through the upper part of the saggital strata.

Experience has shown that the area of destruction and secondary change produced by such a missile is generally of considerable extent. The track would probably admit a finger.

Finally, it may be remarked that in several of the recorded cases of apraxia, and of disturbance of visual orientation and localization, the lesions corresponded more or less closely in position to that probably present in this patient.

A CASE OF KALA-AZAR IN THE MEDITERRANEAN EXPEDITIONARY FORCE.

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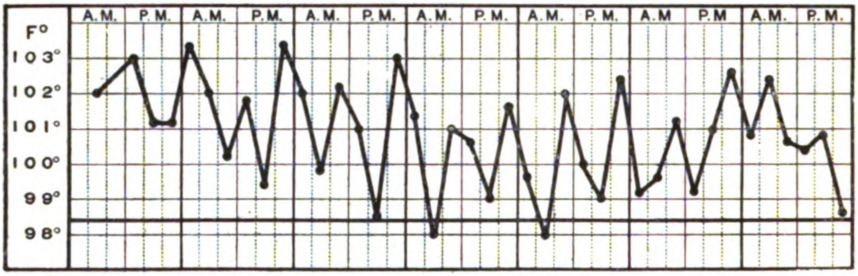
There have been many cases of kala-azar recorded since the discovery of the parasite in 1903, but the following is especially interesting not only on account of its typification of cardinal symptoms, but also on account of its complications. A further point of importance lies in the fact that the patient was a soldier in the British Expeditionary Force to the Mediterranean, and may possibly have contracted the disease either in Egypt or Gallipoli.

Clinical History.—W. C., aged 24, British. Joined the Army at the age of 17. Two years later (1910) he was sent to India, and for four years was stationed at Jubbulpore. From there he was transferred to Calcutta, where he remained until January 15, 1915, when he returned to England. During his sojourn in India, he remained in perfect health.

Ordered to proceed on active service to Gallipoli, he sailed from England on March 26 for Egypt, where he remained until April 22, on

which date he again embarked, and reached the Peninsula April 29. Soon after landing he was in action and received gunshot wounds in the right arm and leg. The former did considerable damage to the lower end of the humerus, but with the exception of some slight subsequent bony deformity both wounds healed without complication.

His terminating illness began on May 7, with a moderately elevated temperature, and the constitutional symptoms incident to a slight pyrexia. The following day he was sent to Malta, and was admitted to hospital May 13. On the morning of the day of admission, his temperature was 103·4° F. reaching 105° F. before night. The next day it had dropped to normal, but on May 15 it had again risen to 104·5° F., from which time it remained more or less high until May 26 when it again fell to 99° F. and remained approximately there for a ortnight.



Temperature chart showing double apex phenomenon.

On June 9, the second pyrexial period began. This lasted for five weeks wherein the temperature never rose above 103·2° F., but showed excursions of two or three degrees twice in the twenty-four hours, illustrating the characteristic double apex phenomenon. The pulse rate varied from 100 to 134 per minute. At this time the true condition was not suspected, but the diagnosis of Mediterranean or enteric fever was tentatively held. It is interesting to note that earlier in this period large doses of quinine were administered without any appreciable effect.

From July 13 to August 1 the temperature was normal, and although very anæmic and emaciated the patient was able to be out of bed and move about to a slight extent. During the first week of August there was a slight rise of temperature, but the succeeding week it was normal. On August 13 began the fourth pyrexial period with a temperature varying between 100·8° F. and 103° F.; the pulse rate was extremely rapid. On August 17, the spleen was palpable for the first time, and a blood count gave the following results: Red blood corpuscles, 1,700,000; white blood corpuscles, 937; differential count: polymorphonuclear, 26 per cent; lymphocytes, 64 per cent; mononuclear, 10 per cent; eosinophile, mast, etc., 0 per cent.

On August 27 the left half of the upper, and right half of the lower lip became reddish and swollen; the mucous membrane of the mouth was dirty, ulcerating and very offensive. In a blood examination neither plasmodium nor Leishmania was found. The mouth and lips became very much worse, the former discharging freely and emanating a most offensive odour. By September 7 the left upper lip, side of the nose, and cheek upwards to within half an inch of the palpebral fissure, and outwards as far as the angle of the mouth, as well as the right half of the lower lip downwards almost to the chin, together with the subjacent tissue, including the outer tables of the bones in both areas, had turned black and gangrenous. Meanwhile the temperature remained high averaging 102° F. to 103° F., with corresponding increase in the rates of pulse and respiration, until September 15, when the sloughs separated, carrying away the two incisor and canine teeth of the left maxilla, and the two right lower incisors, as well as a portion of the outer table of the mandible. After separation of the sloughs the temperature fell to normal, and the margins of the necrosed areas began to granulate, the remaining teeth in affected areas to loosen and the exposed bones to separate.

During the month of October, the patient continued to improve generally although the emaciation, which had become marked during September, did not, in spite of a fairly good appetite, show any marked improvement. The spleen was palpable for a hand breadth below the costal margin, and the abdomen distended and tympanitic.

Watery stools were passed several times daily. Repeated examinations failed to reveal the parasite of kala-azar in the peripheral blood, and the low vitality of the patient did not warrant splenic puncture.

November 1, patient became very drowsy; blood and mucus appeared in the stools; and on this date also began the fifth and final period of elevated temperature. Amœbæ—*Entamœbæ histolytica*—were found in great numbers in the stools, but unfortunately, emetin had no effect on the progress of the dysentery. For a week the patient failed rapidly; the temperature remained between 102° F. to 103° F. Pulse became more rapid, and there were long periods of coma from which he could be aroused only with difficulty. November 9, spleen could be felt just below costal margin. The respirations were 36 and the pulse rate 120 to 130 per minute. Examination of the blood was negative, but the corpuscles had increased in number: Red, 2,600,000; white, 12,500. The following day blood examination was again negative. Respirations increased to 40 or more; pulse imperceptible at the wrist; periods of coma and delirium alternated until death ensued. Immediately after death the spleen was punctured and a smear of the pulp showed many endothelial cells engorged with typical Leishmania.

Post-mortem Findings.—Marked pallor and emaciation; no lesions of the skin except those of the face which were offensive and exuding pus. Left pleura adherent at the base, while in the right cavity there were about ten ounces of fluid. Lungs very œdematous.

A pint of fluid was found in the peritoneal cavity. Liver: firm, weight three pounds, four ounces, sectional surface pale, due to intralobular whitish areas. Spleen: enlarged, dark, mottled, firmer than normal and retained shape for a time after removal; weight two pounds, five ounces. On section very congested, friable, and dark-reddish purple in colour. Kidneys: slight cloudy swelling. Intestines: lower portion of ileum showed numerous pin-head-sized hemispherical red areas—congested solitary follicles. In the cæcum there was an oval transverse gangrenous ulcer $1\frac{1}{2}$ inches by $\frac{3}{4}$ inch in dimensions, situated close to the base of the appendix. The slough extended through the muscular, involving the serous coat, and appeared to be on the point of rupturing. The upper eighteen inches of the colon were normal but from that point lesions appeared with ever-increasing frequency as far as the pelvic colon and rectum. These lesions were small circular discrete ulcers—up to $\frac{3}{8}$ inch in diameter—with black gangrenous circumference and grey sloughing centres extending into the muscular coat. Bone marrow: from the middle of the femur, pale and yellow.

Microscopic Examination.—Spleen smears showed large numbers of endothelial cells, many of which were engorged with typical Leishmania. A small number of parasites were found free and others were embedded in a matrix, which stained pale blue with Giemsa stain and was probably a detachment of an endothelial cell. Similar appearances were observed in the bone marrow films and to a less extent in those from the liver and lungs. No parasites could be found in the smears made from the intestinal ulcers.

Three chief types of Leishmaniasis have been recorded:—

(i) Indian kala-azar due to *Leishmania donovani* (Laveran and Mesnil, 1903).

(ii) Infantile kala-azar caused by *L. infantum* (Nicolle, 1908).

(iii) Oriental sore or Baghdad button due to *L. tropica* (Wright, 1903).

Whereas the last is a localized lesion of the skin and need not concern us further the first two are general infections and present many points of similarity. Certain distinctions have been drawn between these two types and some years ago they were summarized by Leishman as follows:—

(1) Infantile kala-azar which is found mainly around the Mediterranean attacks almost exclusively young children, while the Indian variety is met with at all ages.

(2) Various differences of symptomatology have been described.

(3) *Leishmania infantum* is readily cultivated upon the Novy MacNeil medium and is easily subcultured. *L. donovani* cultures on this medium are as a rule unsuccessful and subcultures cannot be made. On the other hand, cultures of *L. donovani* succeed in citrated splenic blood but this usually fails with *L. infantum*.

(4) Inoculation of the spleen parasites into dogs and monkeys

reproduces the disease in the case of *L. infantum* but not in that of *L. donovani*.

(5) Spontaneous infection of dogs has been found in the endemic areas of infantile kala-azar, but no such infection has been encountered in India.

As a result of recent work these supposed differences have, however, gradually disappeared. In the Mediterranean area records of cases of infection in adults are becoming increasingly common, and certain symptoms, such as cancrum oris, which were supposed to be absent, have been noted frequently in some localities, whereas the duration of the disease may be exceedingly short. Absence of intestinal ulceration has been held to constitute a difference from the Indian disease, but lately this condition has been noted in cases occurring in the former area. Finally, the supposed cultural differences have been shown to be fallacious and the pathogenicity of the parasites from the two areas, for monkeys, dogs and mice has been shown by Laveran, Wenyon, and others to be similar.

A considerable amount of work has been done by Wenyon, Patton, Basile and others, with the object of ascertaining the agents responsible for the transmission of the virus. Although the evidence adduced incriminates bugs and fleas to an extent much more information is required on this subject.

As mentioned at the beginning of this note it is of considerable importance to determine where the patient—a soldier in the Mediterranean Expeditionary Force—acquired the infection. Was it in India, in Egypt, or in Gallipoli? The history shows that although the patient left India in January he did not exhibit any indication of disease until he was wounded in Gallipoli about four months after his departure from India. As there is no reliable means, clinical or otherwise, of distinguishing between the Indian and Mediterranean types of kala-azar the symptoms exhibited by the patient do not assist us in deciding where the disease was contracted. Assuming that he was infected just prior to leaving India, the incubation period was at least four months. This appears to be rather long, but nevertheless, in the present state of our knowledge we cannot on this account exclude the possibility of his having contracted the disease there. If, on the other hand, the infection was contracted in Egypt or Gallipoli the incubation period was less than a month.

The actual diagnosis of kala-azar depends on the recognition of a parasite. Although Donovan and others have recorded that they have found the parasites in the peripheral blood in a large proportion of cases these are usually present in very small numbers only and frequently the examinations are in vain. In this particular case the results of blood examination at various stages of the disease were negative. The parasites were not discovered until after the death of the patient, when spleen puncture revealed their presence in large numbers. In the human body

Leishmania are found chiefly in endothelial cells and more rarely in leucocytes. They consist of an oval body containing a large diffusely-staining trophonucleus and a small rod-shaped sharply staining kinetonucleus; they are small in size measuring 2 to 3·5 μ in length and about 1·5 to 2 μ in breadth.

Puncture of the spleen during life is not without danger in a disease like kala-azar where the organ is congested and greatly increased in size; the capsule is liable to be torn and grave or even fatal hæmorrhage may result. It is as well, therefore, to consider the symptom-complex by which the condition may be recognized clinically.

Fever.—There are two important points to be observed from the temperature chart of a case of kala-azar. The first is that there are alternating periods of pyrexia and apyrexia; and the second that during the pyrexia the curve shows two distinct elevations—the characteristic double apex—every twenty-four hours.

Anæmia and Emaciation.—These two symptoms are always well-marked; the latter in this patient was so extreme that the case resembled one of prolonged starvation.

Enlargement of the spleen is of constant occurrence. Here it extended to the umbilicus three weeks before death, but diminished considerably during the last week of life when the patient had severe diarrhœa.

Blood Examination.—Although no Leishmania may be found in the peripheral blood yet the absence of malaria parasites and the existence of a well-marked leucopænia—1,000 or less per cubic millimetre in half the cases—especially when this is accompanied by a great relative increase in mononuclear leucocytes, support strongly a diagnosis of kala-azar. It is interesting to note in this case that, whereas early in the disease the leucopænia was less than 1,000 per cubic millimetre, towards the end, after recovery from cancrum oris, there was a leucocytosis of 12,500 per cubic millimetre. The number of red corpuscles usually falls to between 2,000,000 and 3,000,000 per cubic millimetre.

In addition to these cardinal symptoms there were in this patient two conditions which also afforded considerable aid to the diagnosis, namely, cancrum oris and dysentery. The former was severe resulting in great loss of tissue and deformity; nevertheless it is noteworthy that the patient recovered from it, his general condition subsequently improving. Dysentery, if it occurs, generally develops late in the course of the infection. The first dysenteric symptoms appeared about a fortnight before death. Examination of the stools revealed the presence of numerous large actively motile amœbæ which, on suitable fixation and staining, were found to be the typical vegetative variety of *E. histolytica.* Whether the ulceration in the cæcum and colon found at the post-mortem examination was due to the Entamœbæ or Leishmania, or whether it was the result of some unknown agent—none of the dysenteric bacilli could be isolated—we are unable to throw light. The

patient was treated with emetin without any amelioration of the dysenteric symptoms. No Entamœbæ or Leishmania were discovered in smears made from the ulcers.

In conclusion, we wish to point out that the practical significance of this case is the possibility that infection may have occurred in Egypt or Gallipoli. Should this be so, other instances of this infection in the Mediterranean Expeditionary Force are to be expected.

A SHORT DESCRIPTION OF EIGHT CASES OF SEVERE COLLAPSE, WHICH WERE REGARDED AS THE CHOLERAIC TYPE OF BACILLARY DYSENTERY.

By Captain J. B. FISHER.
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No. 1, Pte. B.—Had been quite well until slight diarrhœa began on June 9, 1916. On the morning of June 10, 1916, this became very severe, and he stated that he passed blood-stained mucus. He was found collapsed at the latrines and brought up to hospital from Sidi Bishr Camp. Admitted 12.30 p.m., June 10, 1916.

Condition.—Extremely restless and crying out with "cramps" in the abdomen and legs. Very cold, semi-conscious, cyanosed and looking toxic, vomiting profusely. Tongue very furred. Owing to the amount of diarrhœa which patient had already had, his bowels were practically empty, but the few stools he passed consisted entirely of greyish mucous sloughs, some of which were slightly blood-stained. There was no fæcal material and practically no serous fluid.

Treatment.—12.45 p.m.: Morphia, ¼ grain, for the pain; anti-dysentery serum, 100 cubic centimetres. The patient was so restless that he had to be held down while this was injected. 5 p.m.: Quite comfortable; no more pain or vomiting. June 11, 1916: Out of danger, but very drowsy. Constipation. Mental condition of the patient now normal. Convalescence uninterrupted. The first motions were not plated for dysentery bacilli, and owing to the rapid action of the serum no more were obtained suitable for plating. Vibrios were not seen in the stools. The agglutination test was not made.

No. 2, Pte. P.—Had had slight diarrhœa for three weeks before admission. June 26, 1916: Sudden onset of severe diarrhœa at 2 p.m. Admitted 10 p.m., June 26, 1916, from Sidi Bishr Camp.

Condition.—Cold and clammy. Very restless, cyanosed and toxic looking. Complaining of cramps in the arms, legs and abdomen. Vomiting clear fluid. Incontinence of mucus and shreds of fibrin-like material; no fæcal material. Tongue clean. Tendency to Cheyne-Stokes breathing. Pulse just perceptible. Abdomen tender over the cæcum and colon.

Treatment.—10.30 p.m.: Morphia ¼ grain for the pain; strychnine, pituitary and digitalin for his heart; anti-dysentery serum, eighty cubic centimètres. June 27, 1916, 9 a.m.: Still appeared toxic, but was not so cold and clammy. Pulse better. Cramps no longer present. Anti-dysentery serum eighty cubic centimetres again injected. The stools contained mucus and small pieces of material like mucous membrane. June 28, 1916: Patient now convalescent. His recovery was subsequently uninterrupted. No dysentery bacilli were isolated from the stools and no cholera vibrios were seen in them. The agglutination test was not made.

No. 3, Serjt. M.—Had been attending the doctor for some time for headache and giddiness. July 4, 1916: Onset 2 p.m. Between 2 p.m. and 6 p.m. the bowels were opened five times. Admitted 6 p.m. from Sidi Bishr Camp.

Condition.—Cold, pale, seemed very ill. Temperature, 97° F.; pulse, 72. Tongue furred. Complaining of abdominal pain. Abdominal examination negative. 6.30 p.m.: Rigor. Vomited a quantity of clear greenish fluid. Passed one stool, at least two pints in volume, consisting of serous fluid and greyish-white mucus. Immediately after passing this stool patient was found to be very much collapsed; he also became very thirsty.

Treatment.—Anti-dysentery serum eighty cubic centimetres and stimulants. The second stool passed half-an-hour later consisted of greyish-white mucus and mucous sloughs floating in blood-stained serous fluid. 8.30 p.m.: Patient rather better. A stool now passed consisted of shreddy blood-stained mucus of the type commonly seen in bacillary dysentery cases. There was no longer any pain. July 5, 1916: Patient better. Vomiting had ceased. Stools still blood-stained with serous fluid and mucus. Tongue very dry and furred. Pulse stronger. Anti-dysentery serum eighty cubic centimetres again injected. July 8, 1916: Patient convalescent. Recovery subsequently uninterrupted. In this case the change in the character of the stools should be noted. Microscopically there were no vibrios in the stools. No dysentery bacilli were isolated. One month later the agglutination reactions were as follows:—

	1 in 50	1 in 100	1 in 200
Bacillus Shiga	0	0	0
B. Flexner	3	3	2

where the figure 3 represents a maximum agglutination reaction and the figure 2 one of medium degree.

No. 4, Pte. C.—Was off duty for nine weeks about Christmas, 1915. Diagnosis: dysentery.

Treatment.—Emetine. Slight relapse April, 1916. Previously to admission, July 10, 1916, had had diarrhœa for one month. Onset, 8 a.m., July 10, 1916, with severe diarrhœa which gradually became worse. Vomiting began at 10 a.m., but by this time he had lost control over the rectum. 10.30 a.m.: No longer able to walk. In addition to the

diarrhœa and vomiting, he had severe cramps in the abdomen and legs. Admitted 4 p.m. from the house of some friends with whom he was staying.

Condition.—Icy cold, pulseless, speechless, perspiring, eyes sunken, cyanosed. Incontinence of greenish mucus into his clothes and bed.

Treatment.—4·5 p.m.: Intravenous saline infusion 3 pints, to which anti-dysentery serum 80 cubic centimetres, strychnine $\frac{1}{30}$ grain, atrop. sulph. $\frac{1}{100}$ grain, brandy 1 ounce, and pituitary extract $\frac{1}{2}$ cubic centimetre, were added. Ether, 15 minims, and 5 minims of a 1 in 1,000 solution of adrenalin chloride were given subcutaneously. After two pints of the above injection had been given, patient was able to talk, his colour became pink and his pulse could be felt. 5 p.m.: Rigor. Temperature rose to 103° F. 6 p.m.: Condition satisfactory. 8.30 p.m.: Tendency to go down hill. Pulse more rapid. 9 p.m.: Very rapid change for the worse. Patient became restless, cyanosed, and unable to speak. His pulse could no longer be felt at the wrist. Another intravenous injection of two pints of hypertonic saline solution was given. To this, forty cubic centimetres anti-dysentery serum were added. Patient again became of good colour. Strychnine $\frac{1}{60}$ grain was ordered two-hourly. July 11, 1916: Patient appeared out of danger. Occasional hiccough. Passed a little urine. The motions contained greenish-yellow mucus. July 12, 1916: Stools now fæcal. At 9 a.m. the patient was found sitting up in bed reading the paper. Recovery was uninterrupted. The first stools passed were not plated for dysentery bacilli, and vibrios were not seen in them. The blood was taken for the agglutination test, July 29, 1916. Result:—

	1 in 50	1 in 100	1 in 200
B. Shiga	3	3	3
B. Flexner	3	2	1

It will be seen that during the period of five and a half hours (4 p.m. to 9.30 p.m., July 10, 1916) this patient received intravenously five pints of saline and 120 cubic centimetres of anti-dysentery serum.

No. 5, Pte. J.—Has been five months in Egypt, during which time he states he has never been really well. Had had two slight attacks of diarrhœa. Onset of this attack was during the evening of July 7, 1916. Diarrhœa the whole night, followed by vomiting. There was also abdominal pain and headache. He does not know what his motions were like. Admitted on the morning of July 16, 1916, from Montazah. Pulse 100. Very weak. Vomiting all over the bed. Diarrhœa now better. Patient bathed in perspiration and rather cyanosed.

Treatment.—Anti-dysentery serum, 100 cubic centimetres injected subcutaneously. July 17, 1916: Better. August 8, 1916: Discharged to duty. There were no complications. Agglutination reaction:

	1 in 100	1 in 200
B. Shiga	3	3
B. Flexner	0	0

No. 6, Pte. B.—Had dysentery in 1915, in Gallipoli Peninsula; has had slight diarrhœa off and on since then. Onset sudden during the night of July 13, 1916. Symptoms: Headache, diarrhœa and vomiting. Admitted from Montazah on the morning of July 14, 1916, with the provisional diagnosis of heatstroke.

Condition.—Collapsed and cold, bluish ashy-grey colour, pulse thready and feeble, suffering from air hunger. Brandy given. Half-an-hour later passed a foul yellow watery motion containing a large quantity of mucus. This stool was microscopically examined and after it was reported free from vibrios, he was transferred to the dysentery section. Condition on arrival 12 noon: Short of breath, cyanotic, great pain in the back, pulse very feeble.

Treatment.—Intravenous injection of 1½ pints of hypertonic saline solution to which anti-dysentery serum 100 cubic centimetres, atrop. sulph. $\frac{1}{100}$ grain, and a little brandy were added. This was followed by marked improvement for an hour. 2 p.m.: Not so well. Pulse 140. Still cold. 2.30 p.m.: Pulse more rapid, air hunger re-commencing. Very thirsty. 3 p.m.: Worse. Urine had not passed since admission. 4.30 p.m.: Much worse, extremely restless and cyanosed. He was now given four pints of saline solution intravenously to which anti-dysentery serum 20 cubic centimetres, pituitary extract ½ cubic centimetre, brandy 1 ounce, morphia $\frac{1}{12}$ grain, strychnine $\frac{1}{30}$ grain, and digitalin $\frac{1}{100}$ grain were added. After 2½ pints had been given the patient became comfortable and after four pints his pulse was steady and regular, though he still looks rather livid. The first motion passed after his admission to the dysentery section was like thick ground rice pudding both in appearance and consistency. Its volume was about one pint. 8.30 p.m: Pulse steady and regular. Patient comfortable. Flushed face. Temperature 101·4° F. 10 p.m.: Condition satisfactory. Brandy and cardiac stimulants were ordered. July 16, 1916, 9 a.m.: The bowels were reported to have been opened eight times during the previous night. Stools still like rice-water. Pulse regular. 5 p.m.: Bowels moved twelve times during the day. July 18, 1916: Patient better, no further intestinal symptoms. August 6, 1916: A mitral systolic bruit developed, so the patient was transferred to a medical ward. No dysentery bacilli were isolated. The blood taken on August 6, 1916, agglutinated dysentery bacilli as follows:—

	1 in 50	1 in 100	1 in 200
B. Shiga	2	2	2
B. Flexner	0	0	0

The total saline and serum given in this case was 5½ pints and 120 cubic centimetres, respectively during 4½ hours.

No. 7, Cpl. W.—Sudden onset, 8 p.m., July 25, 1917: Headache and vomiting, followed about midnight by abdominal pains and diarrhœa. This continued all night. Admitted 9 a.m., July 26, 1916, from Sidi

Bishr Camp. Condition very restless, short of breath and repeatedly vomiting. Pulse 140. Temperature 102° F. Could not keep still on account of cramp-like pains in abdomen and legs. There was marked air-hunger. He became rapidly worse. 9.30 a.m.: Intravenous saline infusion 3½ pints (hypertonic) to which anti-dysentery serum 100 cubic centimetres, strychnine $\frac{1}{30}$ grain, digitalin $\frac{1}{100}$ grain, brandy 1 ounce, adrenalin chloride (1 in 1,000) 5 minims, and pituitary extract ½ cubic centimetre were added. During the infusion patient had a rigor and subsequently his temperature rose to 102·4° F. He continued restless until all the injection was given, though his colour became better and the air hunger much less marked. 11 a.m.: Vomiting had now ceased. He was comfortable and went to sleep. 11 p.m.: Still comfortable. His bowels had been opened three times during the day. The stools contained clear greenish mucus. July 27, 1916, 9 a.m.: His stools were reported to have been very frequent during the night. They now consisted of blood-stained and greenish mucus. Vomiting re-commenced. Pulse regular. Colour good. July 28, 1916, 9 a.m.: Stools still uncountable and as above. Vomiting had again ceased. Tongue clean. Pulse 70 and of good volume. Temperature normal. Labial herpes present. Eighty cubic centimetres more anti-dysentery serum injected. July 30, 1916: Stools now fæcal and containing some clear mucus. July 31, 1916: Patient quite well. The bowels had only been moved once in the previous twelve hours. August 13, 1916: There was a very severe serum reaction. August 20, 1916: Now convalescent. No dysentery bacilli were isolated and when first admitted no cholera vibrios were seen. The agglutination reaction was negative to Shiga and Flexner. The interest here lies in the fact that though the early and severe collapse improved immediately after the injection of saline and serum, there was subsequently, three days later, a partial relapse the symptoms of which consisted of extreme diarrhœa and the passage of blood-stained and greenish mucus. In fact after the original collapse was overcome the clinical signs changed from being those of the choleraic to those of the ordinary type of bacillary dysentery. Case No. 3, previously described, was somewhat similar but not so far advanced, for he had only been ill for four hours before admission.

No. 8, Pte. S.—In this case there was a sudden onset about 2 p.m., April 20, 1916. The usual symptoms, viz., severe diarrhœa, vomiting, and cramp-like pains were present. Later he became so collapsed that at 6.30 p.m. one of my colleagues carried out intravenous saline infusion. His stools were like rice-water. On microscopic examination, Captain Willmore reported absence of cholera vibrios but stated that the appearance under the microscope reminded him exactly of cases of proved bacillary dysentery often seen by him both in this hospital and at the Quarantine Station at El Tor. I saw him first at 8.30 p.m; he was still in a critical condition. Eighty cubic centimetres anti-dysentery serum were injected subcutaneously and stimulants and morphia ordered.

On the following morning, April 21, 1916, he was much better, but sixty cubic centimetres more serum were given during the course of the day as it was feared he might relapse. Recovery was subsequently complete. One month later his blood was found to agglutinate *B. Flexner* very strongly but not *B. Shiga*.

In these cases a diagnosis of bacillary dysentery rather than ptomaine poisoning was made on the following grounds:—

(1) As a general rule diarrhœa preceded vomiting and was the chief complaint of the patient.

(2) The motions of some of the cases changed from being like rice-water in character to blood-stained and greenish mucus. This did not occur in the worst cases as they were too collapsed and had already lost too much fluid for any more serous fluid or blood to be exuded by the intestinal mucosa.

(3) The immediate and complete response to anti-dysentery serum.

In the more collapsed cases, some of whom seemed moribund, recovery was so rapid that one feels that in addition to the stimulating effect of the saline the toxins must have been completely neutralized.

(4) The cases came in separately; if they had been due to food poisoning one would have expected others at the same time and from the same Camp.

(5) The blood of many of the patients subsequently strongly agglutinated either *B. Shiga* or *B. Flexner*.

If these reactions were due to the serum given at the onset of the illness one would expect both Shiga and Flexner bacilli to have been agglutinated in all cases. On the other hand, it cannot be absolutely proved that some of the patients had not had a mild attack of bacillary dysentery previously, and in any case it is difficult to understand how the blood can develop a strong agglutination reaction when owing to treatment the duration of the acute symptoms is limited to one or two days.

I do not think non-isolation of dysentery bacilli in these cases should be used as a strong argument against the diagnosis, for many of them were so ill that it was difficult to obtain uncontaminated specimens to send for laboratory examination.

I have had six other cases somewhat similar to the above. All were collapsed and five of them required intravenous saline infusion, one of them not being comfortable until five pints had been injected. They all received serum, but are not included in this series of cases, for either the subsequent agglutination tests were negative or weak, or after admission the intestinal symptoms were not so striking. All made an uninterrupted recovery, except the first. When admitted he was pulseless, icy-cold and cyanosed. He also had incontinence of greenish mucus. He was given $2\frac{1}{2}$ pints of saline intravenously and to this sixty cubic centimetres serum and various stimulants were added.

He never rallied and died eight hours later. I have since wondered if he had been given 4½ pints of saline and 120 cubic centimetres of serum like some of my later cases whether the result might not have been different. Examination post mortem showed the intestine to be full of material like ground rice pudding and some greenish mucus. The case was too acute for ulceration to have taken place. Plates made were negative and there were no cholera vibrios.

A question naturally suggested on reading these notes is "Which of the remedies used was responsible for the cure of the patients?"

The reasons which led me to adopt the treatment indicated were as follows:—

Many of the cases were in an extremely critical condition, and it was obvious that they would rapidly succumb unless something prompt and drastic was done for them.

The possible diagnoses suggested by the symptoms present on admission were cholera, ptomaine poisoning, or the choleraic type of bacillary dysentery. The first of these was improbable, for there were no cases of cholera in Alexandria at the time, and it will be noted that no vibrios were ever discovered. The second and third diagnoses are more probable.

I argued that if the correct diagnosis was cholera or ptomaine poisoning, an injection of anti-dysentery serum would not do any harm, whereas if it was bacillary dysentery the injection of a large dose would almost certainly bring about a cure—provided always that the patient could be kept alive sufficiently long for its beneficial action to come into play.

In early cases of bacillary dysentery I believe that the curative effect of anti-dysentery serum begins to be noticeable in from five to ten hours after its injection, so that if a collapsed patient can be kept alive for that period the presumption is that serum given immediately after admission will then prove effective.

It will thus be seen that in these cases the idea underlying the treatment was to immediately save life by the intravenous injection of a large quantity of saline, and then to prolong this action as long as possible by the use of stimulants.

In the meantime the beneficial effect of the serum given as early as possible could steadily become more marked.

As I think the cases described in detail were suffering from dysentery rather than ptomaine poisoning, it would not have been correct to have used saline and stimulants only. In this connexion it is only fair to mention that the less collapsed cases recovered with serum alone or with serum aided by cardiac tonics.

The serum used was made either by Burroughs Wellcome, or the Egyptian Government or the Lister Institute.

In order to enable prompt treatment to be given, I always keep an infusion apparatus and a large quantity of 1·2 per cent saline solution ready. For rapid use the latter can easily be heated to the requisite

temperature by the addition of a little boiling water. In actual practice, therefore, the strength of the saline solution injected is considerably more than 0·8 per cent but less than 1·2 per cent.

Apart from the cases mentioned in this paper, I have treated 319 cases of acute bacillary dysentery during the last nine months. In all severe cases treatment has consisted of early and large doses of anti-dysentery serum combined with saline aperients and suitable dieting. The results obtained have been exceedingly gratifying, for only one death has taken place.

BACILLÆMIA DUE TO INFECTION WITH *B. FÆCALIS ALCALIGENES*.

By Temporary Captain C. H. SHEARMAN,
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CLINICAL NOTES.

By Temporary Captain T. G. MOORHEAD,
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In epidemics of disease due to the enterica group of organisms, especially when occurring among troops under war conditions, many cases are met with which are more or less atypical and in which a diagnosis can only be reached with certainty by bacteriological methods.

More especially is this the case under present conditions where the disease as seen is frequently modified by previous prophylactic inoculation.

Without a well-equipped laboratory to aid in the diagnosis by means of hæmoculture and serological tests, many cases of pyrexia due to other causes would undoubtedly be confused with this modified type of enteric, while others which clinically do not resemble enteric, but are proved bacteriologically or serologically to be so, would be overlooked.

In speaking of making a diagnosis in enterica infections, I refer to the three types—*Bacillus typhosus*, *B. paratyphosus* A, and *B. paratyphosus* B—as one group and as causing one disease, viz., enteric, and am not concerned with making a differential diagnosis between the three members of this group, which, of course, can only be done in the laboratory—but rather of differentiating between such an enterica infection and the various other pyrexias of unknown origin.

During the past nine months at this hospital I have had occasion to make blood culture examinations of considerably over a thousand cases of enterica and suspected enterica infections. In the course of this work I have on several occasions recovered in pure culture from the blood of such cases an organism which has up to present been regarded as more or less non-pathogenic, viz., the *B. fæcalis alcaligenes*.

During the height of the enteric epidemic last summer this organism was isolated only on a few rare occasions—two or three times by myself, and a similar number of times by my colleague, Lieutenant Willmore. Recently, however, cases have occurred from whose blood I have isolated the same organism with almost sufficient frequency to constitute a mild epidemic, and quite frequently enough to identify it as having a pathogenic rôle and being the definite cause of a mild pyrexia in which the true condition is a bacillæmia. Further proof of the organism being the causative agent was given by testing the agglutination power of the blood of several of these cases against the various strains isolated, after waiting for a sufficient length of time for specific agglutinins to be formed. In this way it was found that agglutination occurred up to a dilution of one in two hundred of the patients' sera, with homologous and heterologous strains—in some cases in even higher dilutions—while control sera from normal patients failed to agglutinate the various strains even in dilutions of one in fifty.

During the past eight or nine weeks, i.e., the months of March and April, eleven cases have occurred whose blood culture yielded this organism.

It is quite possible that several other cases of pyrexia, which were thought to be modified enteric, but in which no connexion with the enterica group could be proved by blood culture agglutination tests, or by examination of fæces, were really due to infection with this same organism. In this latter condition, as in enteric, blood cultures to be of value must be taken as early as possible in the pyrexial period. As will be seen by reference to the clinical notes of these cases the initial pyrexial period is of short duration, lasting but two or three days. During the past two or three months most of the cases admitted to this hospital have come from camps more or less in the immediate neighbourhood, the men having been ill for two or three days when admitted. All cases sent in as suspected enterica—as most of these fæcalis infections have been—are blood-cultured as soon as possible after admission, either on the day of admission or the day after. In any case the initial pyrexial period may easily have been passed when this is done, so the blood culture in many of these would be sterile. Until recently, infection with this organism not being recognized as a clinical entity no further steps were taken to establish a relationship between these cases and the organism in question, but subsequent pyrexial periods lending colour to the view that they were modified enterics, agglutination tests and fæces examinations were carried out, but in several instances no connexion with the enterica groups could be proved.

Some of these cases might well then be assumed to be unrecognized cases of infection with *Fæcalis alcaligenes*. This assumption is further borne out by the fact that since we have recognized that this organism may give rise to a definite pathological condition, I have tested the

agglutination titre of the serum in some of the above-mentioned doubtful cases, and have found that in two or three of them the titre ran up to one in 400 for this organism, while for the members of the enterica group it was practically *nil*—what little agglutination for this group was present being no more than would be expected in inoculated subjects. The points which I consider worthy of note in recording these cases are, firstly, that infection with this organism may clinically be mistaken for modified enteric, from which it can only be diagnosed with certainty by hæmoculture or serological tests; and, secondly, that an organism which has hitherto been regarded as practically non-pathogenic may invade the blood stream and so give rise to a definite train of symptoms —a disease of which the dominant sign is pyrexia.

With regard to its pathogenicity it is quite probable that in colder and more temperate climates the organism merely occurs as a harmless member of the intestinal flora, but that in climates such as this where gastro-intestinal disturbances are rife—especially among fresh troops who are exposed to unusual hardships before becoming acclimatized—the catarrhal condition of the bowel so set up provides a *locus minoris resistentiæ*, and the organism, hitherto passive and harmless, now assumes an active rôle and invades the blood stream. Macé, in referring to Petruschky's original description of this organism, states "Il se place tout au voisinage du Bacille typhique dont il a bien des caractères" (Macé, "Traité pratique de bactériologie," vol. ii, p. 250).

While Petruschky recognized its relationship to the typhoid bacillus the fact that it has so frequently been found to occur in the motions of healthy people and in contaminated matter without as far as I have been able to gather being definitely described in relation to any disease, has undoubtedly led us to assume that it did not occur in a pathogenic rôle. Henderson Smith, in his recent article on "The Identification of the Pathogenic Members of the Typhoid-colon Group of Bacilli," definitely mentions it as constituting a non-pathogenic group.

The characteristics of the strains isolated by me agreed with those as given by Petruschky in his original description of the organism with one or two exceptions, viz., a variability in its motility, and in the case of one strain a rapid tendency to peptonize litmus milk. On some occasions the strains would be freely motile and then for no apparent reason would on other occasions lose their motility while still remaining alive as shown by their power to be subcultured. Probably this variability depended on some slight variability in the composition of the media on which they were grown. Apart from this they agreed in all other respects—i.e., they were Gram-negative bacilli growing abundantly on agar agar as a thick slimy growth, producing intense alkalinity in litmus milk (with the one exception noted) and alkalinity in such of the carbohydrates and alcohols as were at my disposal to grow them on. In peptone broth they rapidly produced turbidity with a very thin

transparent scum on the surface of the medium and, after a few days, a deposit at the bottom of the tube.

No liquefaction occurred in gelatine and no indol was formed.

With regard to agglutination tests with this organism, having no electric shaker I had considerable difficulty in getting a homogeneous emulsion from agar cultures for the purpose of carrying out macroscopic tests. I found it necessary to centrifugalize the emulsion obtained by rubbing up the growth with normal saline, then to pipette off the supernatant fluid and filter it through a sterile filter paper.

In this way a fairly homogeneous emulsion was obtained but control tests in normal saline were always put up when carrying out agglutinations. It was usually found that a very slight amount of pseudo agglutination occurred in these controls—nothing to be compared to the very definite agglutination in those that were positive.

As a further control I repeated the tests microscopically, and the process of agglutination became very apparent when watched under the microscope, thus eliminating any possibility of pseudo agglutination being confused with the actual phenomenon.

The technique used in making the blood cultures was as follows :—

Five cubic centimetres of the patient's blood was drawn off aseptically from the median basilic vein and placed in fifty cubic centimetres of a 2½ per cent solution of taurocholate of soda in distilled water. This was incubated for twenty-four hours, then plated out on MacConkey plates, which were again incubated for twenty-four hours. The agar used in making the MacConkey plates was specially prepared with pancreatized bullock's heart according to a formula by Lieutenant-Colonel Dudgeon.

Colonies from the MacConkey's plate were picked off into mannite litmus agar—stab stroke culture being made to note the presence of gas, if any, as well as the reaction of the organism on the mannite.

The absence of any acidity on this medium with a gradual production of alkalinity was sufficient to differentiate the organism from the enterica group in the preliminary examinations—the further characteristics being worked out later.

None of the strains isolated so far are agglutinated with stock (Lister Institute) typhoid or paratyphoid anti-serum.

It might be as well to mention here that on the first occasion of its isolation I was rather inclined to think that I had recovered a *B. Shiga Kruse* from the blood. Subsequent investigation showed that the organism was not connected with the dysentery group, nor was it agglutinated by Shiga anti-serum.

Since writing the above I have isolated this same organism from a further series of ten cases. In five of these I repeated the blood culture examinations five days after isolating the organism and in two of these I again recovered the organism in pure culture.

In the other three cases in which hæmoculture was repeated the pyrexial period was passed.

In two of these cases I have examined the urine bacteriologically, but in each case it has proved sterile.

On first meeting with these fæcalis infections I was inclined to think they were cases of mild enterica in which the *B. fæcalis* had entered the blood stream with an organism of the enterica group and had outgrown the latter. But agglutination tests with the sera from these cases have failed to show any relationship with the enterica group, while as stated above a specific agglutinin is developed for *B. fæcalis*.

This, together with the fact that in all these cases the organism has occurred in pure culture in the blood, is to my mind sufficient evidence that a genuine and specific infection occurs with this organism.

I am indebted to Lieutenant-Colonel Ledingham, consulting bacteriologist to the Mediterranean Expeditionary Force, for the following notes on the characteristics of the fæcalis group, as well as for the notes on previously reported cases of this infection and for the table of references.

Bacillus Fæcalis Alcaligenes.—The organism to which the name *B. fæcalis alcaligenes* was given by Petruschky in 1896 in view of its intense production of alkali in litmus milk, was orginally recovered by the same observer in 1889 from a specimen of stale beer, and later from human fæces. In many of the cultural tests at that time in vogue for the differentiation of organisms, this bacillus agreed closely with *B. typhosus*, but was sharply differentiated therefrom by its property of rendering litmus milk alkaline. At a somewhat later period the controversy which arose over certain observations by German workers, tending to show the possibility of transforming *B. typhosus* into *B. fæcalis alcaligenes* and vice versa, again drew attention to this organism, but as the observations referred to were discovered to be due to contaminated cultures the matter has only an historical interest for us.

In more recent years, the biological properties of *B. fæcalis alcaligenes* have been fairly fully defined. Krencker [1905], e.g., found that no fermentation took place in media containing glucose or lactose, while Klimenko [1907], who examined a fairly large number of strains, recorded the fact that alkali production only occurred in glucose, galactose, cane sugar, lactose, raffinose, arabinose, and dulcite. It has also been established that the flagella of *B. fæcalis alcaligenes* are always polar and not peritrichial as was originally stated by Petruschky. (N.B. The sugar reactions given by Castellani [1912] for this organism are incorrectly stated.) At the present time, *B. fæcalis alcaligenes* may be defined as an organism occurring in human dejecta, particularly in diarrhœal or dysenteric conditions, and either alone or in association with organisms of the typhoid-paratyphoid-dysentery group, or with non-lactose fermenters such as *B. proteus vulgaris*, *B. Morgan* No. 1, etc. It produces turbidity in broth sometimes with pellicle formation, it produces no indol and does not ferment carbohydrates, media containing which being rendered intensely alkaline, as also is litmus milk. Gelatine is not

liquefied, and there is no pigment formation, though a brownish growth in potato has been described.

Pathogenicity for Laboratory Animals.—The organism possesses little pathogenicity for guinea pigs and mice except possibly when inoculated intraperitoneally in fairly large amounts.

Pathogenicity for Man.—Definite evidence of the pathogenicity of this organism for man is very scanty, although there has been on the part of certain writers a tacit assumption of its association with a low form of gastro-intestinal disease. When found in the dejecta in diarrhœal and typhoidal infections as the sole non-lactose fermenter, it has most commonly been regarded as simply an associated organism which has overgrown the more specific organisms and rendering their recovery impossible. In more recent years, however, a few cases have been reported in which this organism has been recovered from the blood and has apparently been accountable for the clinical symptoms in the respective cases. Thus Straub and Krais [1914] record two cases of which the following are brief notes:—

Case 1.—Female, aged 19. Admitted January 6, 1913. Pain on defæcation with two or three stools a day since middle of December, 1912. Stool formed but containing mucus. On January 2, pains in umbilical region. Since January 4 vomiting of bilious watery material without blood. Little appetite. Temperature 39° C. to 40° C. Pulse 130. Herpes labialis. Heart and lungs normal. Abdomen tender on pressure. No distension. Spleen not enlarged. Temperature fell by lysis from January 11, and patient was discharged on February 8. From the blood a pure culture of an organism allied to the *fæcalis* group, but *liquefying* gelatine was recovered. Total leucocytes 4,500 with relative lymphocytosis. Serum of patient did not agglutinate *B. typhosus* or the two paratyphoid bacilli.

Case 2.—Male, aged 19. Admitted April 24, 1913. Took ill on April 3, with headache and rigors, but continued at work till April 14. He then received ambulant treatment till April 24. On admission, he complained of stabbing pains in the chest, with cough, headache, and night sweats. Stools were regular. Temperature 39.9° C. Pulse 100. Spleen not palpable. Leucocytes 7,100, with fifty per cent of lymphocytes. Fever was continuous till April 30, when a brief remission occurred. It continued, however, at 38° C. till May 12, when it became normal. Patient discharged June 3. There is no record of hæmoculture but from the urine an organism giving all the characters of *B. fæcalis alcaligenes* was recovered on May 17. Twice during the pyrexia (on April 30 and May 3) the urine had been found sterile. This organism did not liquefy gelatine. The serum of the case did not agglutinate typhoid or paratyphoid bacilli but agglutinated the homologous strain of *B. fæcalis alcaligenes*, as well as that recovered from Case 1, in a dilution of 1 in 1,000.

Rochaix and Marotte (1916) give a brief but concise account of two

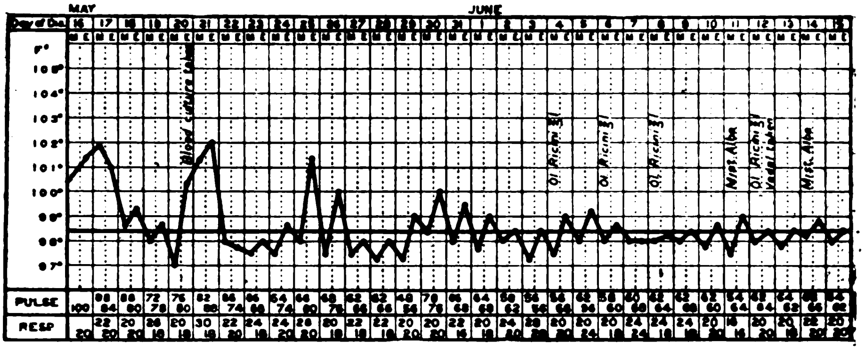
recept cases of benign typhoid-like illness in which typical *B. fæcalis alcaligenes* was recovered from the blood. The two patients complained of gastro-intestinal symptoms. During the first two or three days the temperature oscillated between 39° and 40° C., then fell progressively to normal in ten to twelve days. Blood culture performed on the day following admission gave a pure culture of *B. fæcalis alcaligenes.* Six days later a second hæmoculture proved negative. The sera of the two patients did not agglutinate paratyphoid bacilli but agglutinated *B. typhosus* in 1 in 100 and 1 in 50 respectively (both cases previously vaccinated against enteric). The homologous organisms were, however, agglutinated by the sera of the cases in 1 in 200 and 1 in 500 dilution respectively. Also the serum of the first patient agglutinated the organism recovered from the second case in 1 in 200 dilution, while the serum of the second patient agglutinated the organism of Case 1 in 1 in 1,000 dilution. Two or three isolated and less authenticated cases are here omitted and no evidence is on record of the occurrence of cases of this character in apparently epidemic form. The series of cases of fæcalis infection here recorded by Captain Shearman constitute the first record of what may be called an epidemic prevalence of infection due to *B. fæcalis alcaligenes.*

CLINICAL NOTES OF CASES OCCURRING AT NO. 17 GENERAL HOSPITAL.

Nearly all the cases referred to by Captain Shearman were at first admitted into the Observation Ward of the No. 17 General Hospital, Egypt. This ward was one into which all cases of obscure pyrexia in which no physical signs or symptoms are present to explain the occurrence of the fever when the patient first presents himself, and in which in consequence there is a suspicion of enteric or typhoid fever, are received direct from the reception room. From this ward cases are weeded out day by day as an accurate diagnosis becomes possible.

The symptoms this group of patients complained of may be briefly summarized. In nine out of the eleven cases there was a sudden onset with slight chill, severe headache, usually frontal, but sometimes also felt in the occipital region, nausea, occasional vomiting, and general aching of the limbs. Abdominal pains with constipation were also usually complained of. In two of the cases the onset was gradual, but the symptoms complained of were those above enumerated.

On examination after admission there was very little to note, except in a negative way. In all cases the face was flushed, the tongue furred, and all the usual phenomena of pyrexia were apparent. The pulse was under 100 and not dicrotic; nothing of note was found in the chest; the abdomen was slightly distended and tender on palpation, but no enlargement or tenderness of either liver or spleen was found. The urine was normal, and in each case the diazo test was negative. In one patient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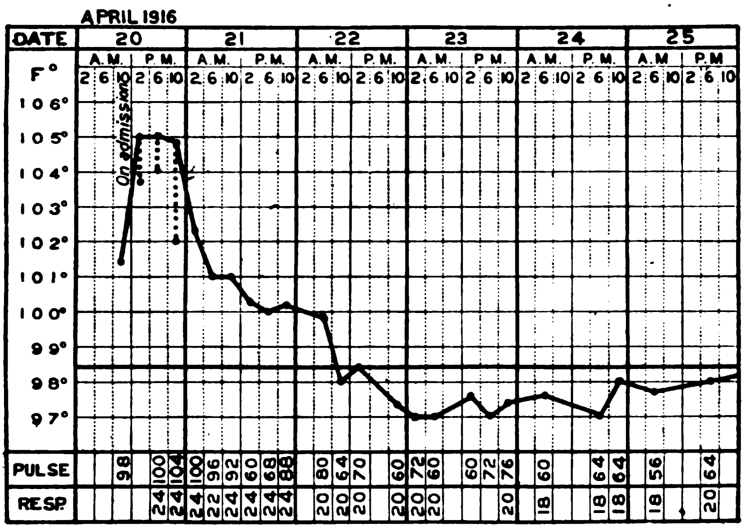
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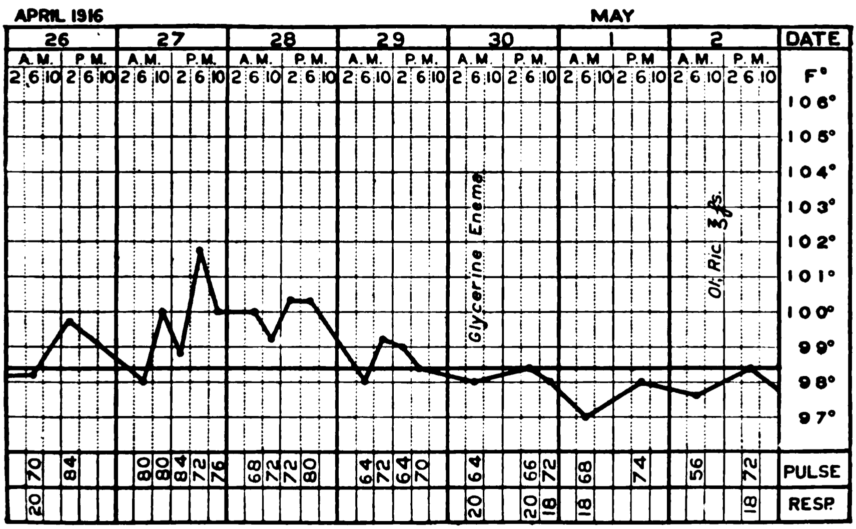
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there was a diffused urticarial eruption which disappeared in twenty-four hours, but returned a few days later.

The type of temperature recorded was interesting. In nine cases there was an initial period of pyrexia of from two to five days' duration, reaching a height of from 101° F. to 102° F., and falling by lysis. This was followed by a normal period of from two to five days, after which there was a second pyrexial period similar to the first, but lasting only two to three days, during which period there was a return of all the symptoms complained of at the beginning. In two cases there was a third rise of temperature similar to the second and third. In two cases no second pyrexial attack occurred.

Blood examinations, apart from the bacteriological findings, threw no light on the condition. The white cell count, with one exception, was in each case examined under 10,000 per cubic millimetre, averaging about 8,800, and the differential count was normal.

No spirillæ or malarial parasites were found. In one case a leucocytosis of 16,090 was found. As it is probable that cases similar to these are occurring elsewhere, and as in other places where paratyphoid fever is prevalent they might easily be taken for mild and unusual forms of that disease it is important to call attention to their existence. The diagnosis, of course, depends entirely on the bacteriological findings.

Typical temperature charts from two of the cases accompany this note.

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Report.

REPORT ON CEREBROSPINAL FEVER IN THE LONDON DISTRICT, DECEMBER, 1915, TO JULY, 1916.

By Captain MARTIN FLACK.
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I.

THE following is a report of observations and investigations made with regard to cerebrospinal fever amongst troops in the London district from December 6, 1915, to July 31, 1916.

Laboratory Technique.—The technique pursued in the London district Cerebrospinal Fever Laboratory has been that recommended by the Officer-in-Charge of the Central Cerebrospinal Fever Laboratory. Owing to the proximity of the Laboratories it has been possible for me frequently to consult Lieutenant-Colonel M. H. Gordon, R.A.M.C., and I wish to express my thanks to him and his staff for the very kind way in which they have given me every possible assistance.

Media Employed.—The medium in general use has been the pea extract trypagar medium issued by the Supply Department of the Central Laboratory, of which Major Hine, R.A.M.C., is in charge. For primary growth of the coccus from cerebrospinal fluids a small quantity of fresh human blood is spread over the surface of the plates. For the primary growth of the coccus from swabs of the nasopharynx, two per cent of normal horse serum is added to the medium immediately before pouring the plates. For the purpose of subculture, the medium is employed as issued. For "storage" of the coccus, stabs of starch agar, or more recently "germ" agar, have been used. This latter medium consists of pea flour trypagar, to which an extract of the germ of wheat has been added.

Identification of the Meningococcus.—The identification of the meningococcus has been almost exclusively by serological means. At first differentiation by cultural and fermentative characters was practised in addition, but it was found that by the fermentation of sugars and growth at 23° C., organisms were isolated other than those which have been shown to be associated with epidemic cerebrospinal meningitis. For this reason these tests were early abandoned and the coccus identified solely by the agglutination test. The agglutination test is performed by the macroscopic method as follows:—

The suspected coccus is raised in pure culture from a single colony, emulsified with 0·8 per cent saline, heated to 65° C. for half an hour to inactivate the autolysin, and standardized to 2,000 million per cubic centimetre, 0·5 per cent of phenol being added. This emulsion is tested against normal serum, giving an ultimate dilution of 1 in 50 and also in ultimate dilutions of 1 in 100, 1 in 200, and 1 in 400 against the specific

univalent sera for each of the known epidemic types of meningococcus. As a control experiment, cocci of the standard types are tested in similar dilutions against normal serum and their homologous sera. The test is made in small tubes; into each tube is placed ½ cubic centimetre of serum dilution and ½ cubic centimetre of emulsion. The tubes are then well plugged with cotton wool and placed in an incubator for twenty-four hours at 55° C. The results of the test may be exemplified as follows :—

Cocci	N.S.	Type I serum			Type II serum			Type III serum			Type IV serum			Remarks
	1/50	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	1/100	1/200	1/400	
"A"	—	+ +	+ +	+ +	—	—	—	—	—	—	—	—	—	Type I agglutination.
"B"	—	—	—	—	+ +	+ +	+ +	—	—	—	—	—	—	,, II ,,
"C"	—	—	—	—	—	—	—	+ +	+ +	+ +	—	—	—	,, III ,,
"D"	—	—	—	—	—	—	—	—	—	—	+ +	+ +	+ +	,, IV ,,
"E"	—	+ +	+ +	+ +	—	—	—	+ +	+	(+)	—	—	—	,, I-III ,,
"F"	—	—	—	—	+ +	+ +	+ +	—	—	—	+ +	+	(+)	,, II-IV ,,
"G"	—	+	—	—	+	—	—	+	—	—	+	—	—	Group agglutination.
"H"	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	Flavus ,,
"J"	—	—	—	—	—	—	—	—	—	—	—	—	—	Negative ,,

Note :—+ + = Complete agglutination. + = Partial agglutination.
(+) = Slight agglutination. N.S. = Normal serum.

It will be seen that a meningococcus of epidemic type is completely agglutinated by one or other of the standard sera. As a rule the differentiation is sharp, but in some cases an epidemic strain, in addition to complete agglutination with its type serum, is also agglutinated in part by certain of the other standard sera. There is no agglutination with normal serum. Thus, as shown in the table, a Type I coccus is agglutinated completely by Type I serum and sometimes also in part with Type III serum. Again, Type II coccus may be agglutinated in part by Type IV serum. Other variations are also possible. In most cases the type of coccus is indicated by the serum with which it shows the most complete agglutination, but in cases of doubt the exact type of coccus is finally determined by employment of the absorption of agglutinin test.

Nasopharyngeal cocci culturally resembling the meningococcus, but failing to qualify serologically, may give one of three results.

(*a*) Complete agglutination by normal serum and by all the standard sera, such a coccus being probably that which has been designated by v. Lingelsheim as *M. flavus III* (Flavus agglutination).

(*b*) No agglutination by normal serum, but a partial agglutination to a dilution not exceeding 1 in 100 by all or one of the standard sera. This has been designated "group" agglutination.

(*c*) No agglutination by the sera, normal or standard. Such a coccus

belongs to the group of cocci which are perhaps best termed "pseudo"-meningococci. (This is termed here "negative" agglutination.)

II.

Routine Procedure.—When information of a suspected case of cerebrospinal fever is received, the routine procedure adopted is as follows :—

If the case be already in hospital, details as to his unit, etc., are ascertained at once by telephone. If the unit be in the London area, the immediate contacts are segregated by telephone, pending investigation of the case. If it appears in the least degree probable that the case is one of cerebrospinal fever, it is lumbar-punctured forthwith and, after withdrawal of the cerebrospinal fluid (usually about seventy cubic centimetres) a thirty cubic centimetre dose of anti-meningococcal serum administered intrathecally. A nasopharyngeal swab is also taken. If, on the other hand, as happens not infrequently, it appears that the case is not one of cerebrospinal meningitis at all, only a swab of the nasopharynx is taken. In probable cases contacts are swabbed without waiting for a positive diagnosis. In this way several hours of quarantine are saved.

In regard to the hospital contacts, these are determined by the following considerations. If the case has been admitted but a few hours it is deemed sufficient to swab the patients in the two or three beds on either side, and in the four or five beds opposite, together with the nurses and orderlies in attendance on it. If, however, the case has been in the wards for several days or longer, all the inmates of the ward and members of the nursing staff in attendance are swabbed.

In regard to the regimental contacts, a somewhat similar method of procedure is adopted. In the first place it is deemed sufficient to swab only such intimate friends of the man as can be found, and those men who occupy the same hut or barrack room. If, however, the hut be of large dimensions, then it is held to be sufficient to swab the thirty to fifty men in the immediate vicinity of the patient's sleeping place. Should, however, a large percentage of positive contacts be found among these, then it is deemed advisable to swab on a considerably larger scale. Any friends of the positive carriers who have not already been swabbed are then swabbed, and if any such be found to be carriers, then members of their hut or room are also swabbed. By this means a large number of carriers not direct contacts of the case may be detected.

All nasopharyngeal swabs are plated on the spot and the plates carried in the heated water-jacketed tins supplied for the purpose. The cerebrospinal fluid removed from the case is also kept from cooling in order that, if possible, a growth of the meningococcus may be obtained.

When a positive diagnosis has been made, the case is removed to special cerebrospinal fever wards for treatment. Positive carriers are sent to isolation wards at another military hospital.

III.

Cases of Cerebrospinal Fever.

During the period comprised, sixty-one military cases of cerebrospinal fever came under investigation in the London district. This number includes a case (R. H.) which was possibly one of mild cerebrospinal fever supervening upon tuberculous meningitis. The cerebrospinal fluid of this case remained persistently clear, and although at first Gram-negative cocci were found microscopically, no growth of the meningococcus was obtained from the cerebrospinal fluid or from the nasopharynx. Neither this case nor one (D. B. H.) of whom information was only obtained a month after death, and in which the diagnosis is by no means certain, is included in the subsequent tables.

Distribution of Cases.—Of the sixty cases (including one Pte. D., treated at Bristol), twenty-nine occurred among London district troops, and thirty-one were men from overseas or other commands who developed the disease within the London area. The distribution of the London district cases may be summarized as follows :—

Station	Number of cases	Type I	Type II	Type III	Type IV	Remarks
"A" Depot ..	7	..	7	..	..	These cases were distributed among five different regiments.
"B" Depot ..	4	..	4	..	..	One case developed while on leave at Bristol.
"C" Camp ..	2	..	1	..	1	Cases from different regiments which had no contact with each other.
"D" Barracks..	2	..	1	..	1	..
"E" Hospital ..	1	..	1	..	..	Probably infected by case in same ward.
"F" Army Office	1	..	..	..	..	Coccus not examined by London District Laboratory.
"G" Camp ..	1	..	1	..	..	..
"H" Hospital	1	1	..	..	..	Orderly of hospital.
"I" Camp ..	1	..	..	..	1	..
"J" Barracks ..	1	1	..	..	..	..
"K" Depot ..	1	..	..	..	..	..
"L" Camp ..	1	1	..	..	..	..
"M" Barracks	1	..	..	..	..	Found dead. No culture.
"N" Depot ..	1	..	1	..	..	..
Positive contacts developing disease in isolation	4	1	3	..	..	..
Totals ..	29	4	19	..	3	..

There was nothing of the nature of an epidemic among one particular regiment.

Of the four carrier cases that developed meningitis in isolation, one had been in quarantine for six weeks, and the others for about a week to

ten days. The case in " E " Hospital developed while the ward was in quarantine for a case which had been removed two days previously.

The cases which occurred in the London area among troops other than those of the London district may be synopsized as follows :—

Station	Number of cases	Type I	Type II	Type III	Type IV
France	12	2	9	..	1
Dardanelles	2	1	(One not examined)		
Aldershot	2	1	1	..	..
Bushey Park	1	..	1	..	..
Colchester	1	1	..	..	..
Epsom	1	1	..	..	..
Hornchurch	1	..	1	..	..
Larkhill	1	..	..	..	1
Lydd	1	..	1	..	..
Prees Heath	1	..	1	..	..
Pirbright	1	1	..	..	..
Salisbury Plain	1	..	..	1	..
Shoreham	1	..	1	..	..
Sittingbourne	1	..	1	..	..
Wendover	1	..	..	..	1
Witley	1	1	..	..	..
Bordon Camp	2	..	2	..	..
Totals	31	8	18	1	3

Time of Occurrence of Cases.

No cases occurred in the London district during November. Since then the number of cases has been as follows :—

	Total cases	Cases among London district troops	Cases from other Commands or Overseas
December	7	3	4
January..	7	3	4
February	5	2	3
March	19	12	7
April	8	5	3
May	5	2	3
June	4	1	3
July	5	1	4

It will be seen that cases among the London district troops followed a well-defined curve, whereas there is no such marked curve for cases coming in from overseas or outside commands.

The increase in cases during July is due almost solely to the disease developing among men from France, three of the four outside cases being recent arrivals from the front.

Type of Case, Clinical Symptoms, etc.

In the early months, certain of the cases given above were not seen by the bacteriologist in charge, but were early removed to isolation hospitals. Later in the season, the majority of cases were first seen by the bacteriologist, and were subsequently treated in wards allotted for this purpose. The following synopsis of signs and symptoms is based chiefly upon the latter cases.

Onset.—In general, the onset of the disease was acute, but in a small minority of cases there was a history of a gradual onset.

Headache.—Intense headache was present in every case.

Vomiting.—Vomiting was present generally, although in one or two cases which were early diagnosed there was a history of nausea only.

Mental Conditions.—This showed variation. Frequently there was well-marked delirium, while in other severe cases the mental condition, although somewhat dulled, was relatively good. In some cases with gradual onset, mental confusion or loss of consciousness was the first sign of the disease. One case subsequently diagnosed as cerebrospinal fever was found wandering in the Edgware Road suffering from loss of memory and practically no other symptoms. The first symptom in another case was that he fell down unconscious on parade.

Neck Rigidity.—This was present in every case save one, namely, the case found wandering from loss of memory. On the first day of the disease, except in fulminating cases, the rigidity is slight but distinct, becoming generally well marked on the second day of the disease.

Head Retraction.—In many cases the rigidity of the neck is also associated with marked retraction of the head.

Temperature.—In the early stages in the acute cases there was a marked pyrexia often introduced by a rigor. In less severe acute cases, there was also a considerable rise of temperature. In cases of gradual onset, there was little or no pyrexia observed.

Eyes.—Examination of the eyes generally showed some abnormal condition. In many cases the pupils were found to be greatly dilated. In some cases one pupil was observed to be considerably larger than the other. In several cases a lateral nystagmus was observed. Generally speaking, photophobia was not present.

Pulse.—In the majority of cases, a pulse slow in comparison with the degree of pyrexia was found. In general, the pulse showed no relationship to fluctuations of temperature, and frequently showed a marked irregularity of rate, often a sign of considerable import.

Abdominal Reflexes.—In the majority of cases these were found to be either markedly heightened or abolished.

Bladder.—Retention of urine was present in a number of cases; in others, the urine was passed involuntarily.

Constipation.—This was frequently present in the early stages, becoming very marked in the course of the disease.

Kernig's Sign.—This was found in almost every case, being slight but definite on the first day of the disease and prominent later. It is to be noticed, however, that Kernig's sign of a certain degree was observed at the onset of other cases of fever which were undoubtedly not cerebrospinal fever, namely, influenza, measles, and German measles.

Knee-jerks.—These were sometimes found to be increased, sometimes normal, and occasionally abolished. Plantar reflexes also gave inconclusive evidence. Investigation of knee-jerks and plantar reflexes is not of great value in the diagnosis of cerebrospinal fever.

Eruption.—This was present in a minority of cases.

The points upon which the greatest value was placed in making a provisional diagnosis of cerebrospinal fever in the London district cases were :—

(1) Intense headache.

(2) Vomiting.

(3) Stiff neck.

(4) Increased or abolished abdominal reflexes.

(5) Abnormal condition of the eyes.

(6) Presence of Kernig's sign.

(7) Slow pulse in relation to the degree of fever, with irregularity of pulse frequency.

(8) General mental condition.

The relative severity of these fifty-nine cases of the London district together with their percentage mortality is shown in the following table :—

		Deaths	Percentage mortality
Total cases ..	59	17	28·98
Fulminant cases	7	7	100·00
Severe cases	28	8	28·57
Moderately severe	15	2	13·33
Slight cases	9	—	—

The two fatal cases classed as moderately severe died of acute tuberculosis supervening upon a moderate attack of cerebrospinal fever. In both cases old, as well as new, tuberculous lesions were found post-mortem. Six of the cases were of gradual onset. In these cases the symptoms were somewhat indefinite, diagnosis depending, as mentioned later, upon a few Gram-negative cocci in a clear cerebrospinal fluid, and the presence of the meningococcus in the nasopharynx. The following is a history of such a case until first seen, as given by the Medical Officer :—

"Reported sick on Monday, March 6, complaining of slight giddiness. Detained. Evening temperature 99·6° F. Complains of no pain.

March 7.—Retention of urine. Thirty ounces drawn off.

March 8.—Had a comfortable night, complains of no pain, no vomiting, no headache, no rash; passed eighteen ounces of urine, no albumen, no sugar.

Still has marked vertigo and sways when standing.

Nystagmus when asked to fix his eyes; range of vision appears normal, pupils equal, react normally. Slight increase of reflexes. Distinct blurring of speech. Decubitus. Lies on side. No marked retraction of head and not inclined to curl up. Pulse 68; temperature normal."

When seen later in the day, patient had marked headache, temperature 99° F., mental condition dull, slight but definite stiff neck, abdominal reflexes + +. On lumbar puncture, seventy cubic centimetres of clear fluid were drawn off. This contained polymorphonuclears in small numbers, some Gram-negative cocci, which, when cultivated, were found to be Type II meningococcus. The swab from the nasopharynx showed abundant colonies of meningococcus Type II.

The case subsequently became very severe and developed well-marked typical symptoms.

As already mentioned, another case was found wandering in the Edgware Road in hospital clothes, and brought to the hospital by the police. The patient had completely lost his memory. He complained of his head; his pupils were markedly dilated, and he had great pain in the back of his eyes. The abdominal reflexes were abolished, and a slight Kernig was present.

After being convalescent for some time, the case developed pressure symptoms, which were markedly relieved by a lumbar puncture without serum. In this case the cerebrospinal fluid contained large flakes of fibrin, polymorphonuclears in slight numbers, and Gram-negative cocci intracellular and extracellular which failed to grow. The meningococcus was found in the nasopharynx.

Bacteriological Findings.

The actual diagnosis of cerebrospinal fever was based upon the result of the examination of the cerebrospinal fluid and of the nasopharynx. Generally speaking, a positive diagnosis was made (1) when the meningococcus was grown from the cerebrospinal fluid; (2) when the gram-negative cocci were seen microscopically in the cerebrospinal fluid, and a growth of the meningococcus was obtained from the nasopharynx. In the absence of growth of the meningococcus from the fluid, it is impossible to give an absolutely positive diagnosis of cerebrospinal fever, since other Gram-negative cocci are said to have been found in meningitis, e.g., gonococcus, *M. flavus III*, and *M. catarrhalis*. But the presence of an epidemic type of meningococcus in the nasopharynx, together with

clinical evidences of meningitis and the presence of Gram-negative cocci in the cerebrospinal fluid has been held to be sufficient to warrant a diagnosis of cerebrospinal fever. For administrative purposes, segregation of a patient with the meningococcus in the nasopharynx is important and necessary during an epidemic.

In actual practice it has been found that all cases which have been diagnosed as cerebrospinal fever from the presence of Gram-negative cocci in the cerebrospinal fluid, and have been immediately removed to the cerebrospinal wards, have grown the meningococcus from the nasopharynx. For this reason a swab from the nasopharynx is always taken at the same time that the lumbar puncture is made; and in cases in which the cerebrospinal fluid is at first indeterminate microscopically, or from which a growth of the meningococcus is not obtained, a growth of the meningococcus from the nasopharynx is exceedingly helpful in making a diagnosis.

The agglutination test also has been found to furnish valuable information for the purpose of diagnosis. In three cases in which the meningococcus could not be grown from the cerebrospinal fluid, but was grown from the nasopharynx, it was found that the blood of the patient taken between the fifth and tenth day of the disease agglutinated the same type of coccus as was found in the nasopharynx, but not the other types of meningococcus. According to the day of the disease, the agglutination was positive up to 1 in 40 on the fifth day, and to 1 in 100 on the tenth day. The method used was the macroscopic one, the results being read off after twenty-four hours at 55° C. Controls with normal human serum were carried out in each case.

The Character of Cerebrospinal Fluid.

Generally speaking, the cerebrospinal fluid was found to be very turbid in severely acute cases, turbid in the less severe cases, and faintly turbid or clear in what may be termed the slight cases. These last are, as a rule, mostly cases which have been diagnosed early, and have received specific treatment from the onset. In cases of slow onset the fluid is generally clear or faintly turbid.

In the following table is given (*a*) the character of the fluid on primary puncture, (*b*) the type of coccus found in the fluid when growth was obtained, (*c*) the type of coccus found in the nasopharynx, and (*d*) the result of the disease.

From the above it will be seen that in the fifty-six cases examined, the cerebrospinal fluid was turbid in twenty-seven cases (the case punctured post mortem is not included), faintly turbid or with fine flocculi in thirteen cases, and clear in fifteen cases. The meningococcus was grown from the cerebrospinal fluid in thirty-nine cases or 69·64 per cent of the total number of cases. From turbid fluid the meningococcus was grown in twenty-six, while from clear fluid growth was obtained in five cases.

	Name	Age	Character of cerebrospinal fluid on primary puncture	Type of coccus from cerebro-spinal fluid	Type of coccus from nasopharynx	Result of disease
1	B.$_{1}$	23	Not examined	—	—	Recovery.
2	N.$_{1}$	19	Turbid	I.	Not examined in early stage	,,
3	P.$_{1}$	21	,,	I.	Not examined	Death.
4	M.$_{1}$	25	,,	I.	,, ,,	,,
5	A.$_{1}$	38	,,	I.	Not examined in early stage	,,
6	P.$_{2}$	22	,,	No growth	Not examined in early stage	,,
7	W.$_{1}$	30	,,	II.	Not examined	,,
8	T.$_{1}$	44	Not examined	I.	Not examined by London District Laboratory	Recovery.
9	D.$_{1}$	21	Turbid	II.	II.	,,
10	H.$_{1}$	22	,,	II.	II.	Death.
11	T.$_{2}$	23	Clear	No growth	II.	Recovery.
12	M.$_{2}$	21	Faintly turbid	II.	II.	,,
13	C.$_{1}$	20	,, ,,	II.	II.	,,
14	P.$_{3}$	29	Turbid	I.	I.	,,
15	R.$_{1}$	17	Faintly turbid	I.	I.	,,
16	D.$_{2}$	20	Clear	II.	II.	,,
17	B.$_{2}$	20	Turbid	II.	II.	,,
18	K.$_{1}$	19	Clear	No growth	II.	,,
19	M.$_{3}$	23	Turbid	II.	II.	,,
20	N.$_{2}$	21	,,	IV.	IV.	,,
21	R.$_{2}$	23	Clear	II.	II.	,,
22	M.$_{4}$	27	Turbid	IV.	Not swabbed, ante-mortem	Death in seventeen hours.
23	F.$_{1}$	19	,,	II.	II.	Recovery.
24	F.$_{2}$	27	Turbid L. puncture. P.M.	?	?	Death.
25	H.$_{2}$	21	Clear	II.	II.	Recovery.
26	A.$_{2}$	28	Turbid	II.	Not swabbed, too ill	Death in twenty hours.
27	F.$_{3}$	22	Faintly turbid	No growth	II.	Recovery.
28	T.$_{3}$	22	Clear	,,	II.	,,
29	C.$_{2}$	27	Turbid	I.	I.	,,
30	B.$_{3}$	28	Clear	II.	II.	,,
31	W.$_{2}$	21	,,	No growth	II.	,,
32	F.$_{4}$	20	Turbid	IV.	I.	,,
33	S.$_{1}$	19	Clear	No growth	II.	,,
34	S.$_{2}$	22	,,	,,	II.	Death.
35	O.	21	Turbid	II.	II.	,,
36	N.$_{3}$	19	Clear	No growth	II.	Recovery.
37	B.$_{4}$	20	Faintly turbid	,,	II.	,,
38	W.$_{3}$	20	Clear	,,	II.	,,
39	B.$_{5}$	23	Faintly turbid	Failed on subculture	II.	,,
40	S.$_{3}$	29	Clear	No growth	II.	,,
41	D.$_{3}$	27	Turbid	II.	II.	,,
42	D.$_{4}$	40	,,	I.	I.	,,
43	B.$_{6}$	19	Faintly turbid	No growth	I.	,,
44	W.$_{4}$	24	Flocculent	,,	I.	,,
45	N.$_{4}$	21	Faintly turbid	II.	II.	Death.
46	L.	32	Turbid	II.	II.	,,
47	C.$_{3}$	22	,,	II.	II.	Recovery.
48	H.$_{3}$	38	,,	I.	I.	Death.
49	D.$_{5}$	38	,,	II.	II.	,,
50	W.$_{5}$	23	Faintly turbid	IV.	IV.	Recovery.
51	H.$_{4}$	19	Turbid	II.	II.	Death.
52	M.$_{5}$	20	Clear	No growth	II.	Recovery.
53	S.$_{4}$	25	Faintly turbid	,,	No growth	,,
54	B.$_{7}$	22	,, ,,	II.	II.	,,
55	P.$_{4}$	33	Turbid	III.	III.	Recovering.
56	F.$_{5}$	24	Clear	II.	II.	Recovery.
57	N.$_{5}$	19	Faintly turbid	IV.	IV.	,,
58	McN.	39	Much blood	No growth	IV.	,,
59	G.	20	Faintly turbid	II.	II.	,,

The meningococcus was, however, obtained from the nasopharynx in forty-seven cases, i.e., in every case but one from the time when this point was studied.

The exception was a case which had been treated in a ward for over three weeks as acute rheumatism. Two days after discharge the patient again became ill with signs of meningitis. The cerebrospinal fluid on lumbar puncture was found to be flocculent. One man who had occupied a bedroom with him, three patients in the ward, and the staff nurse of the ward were found to be carriers.

The above results are for convenience tabulated below :—

—	Number of cases	Coccus grown in	Percentage
Cases examined (excluding case lumbar punctured post-mortem)	56	39	69·64
Cases with turbid cerebrospinal fluid ..	27	26	96·29
Cases with faintly turbid cerebrospinal fluid	13	9	69·23
Cases with clear cerebrospinal fluid	15	5	33·33
Cases with much blood in fluid	1	..	..
Cases in which the nasopharynx was examined	48	47[1]	97·91
Cases in which both nasopharynx and cerebrospinal fluid were examined	47	32 from both C.S.F. and N.P.	66·66

[1] The case in which the coccus did not grow was not diagnosed early. It was treated as acute rheumatism for twenty-three days. Six positive carriers were found.

The table also reveals the fact that the coccus in cases of cerebrospinal meningitis was always of known epidemic type; also that where the meningococcus was cultivated from both the cerebrospinal fluid and the nasopharynx it was, with one exception, always the same type. The exception was probably one in which both types of coccus were present in the nasopharynx, since of two positive contacts of the case one yielded Type I and the other Type IV. Both contacts had been in intimate association with the case. Unfortunately, owing to pressure of work at the time, the absorption test could not be applied to these two cocci.

The type of meningococcus found in the cerebrospinal fluid and in the nasopharynx of the cases as a whole is given in the following table :—

—	Type classification of 39 cocci from cerebrospinal fluid	Percentage	Type classification of 55 cocci (including those in which growth occurred in the nasopharynx only)	Percentage
Type I	10	25·64	12	21·81
Type II	23	59·00	36	65·45
Type III	1	2·56	1	1·81
Type IV	5	12·82	6	10·90

The question as to whether more than one type of meningococcus occurs in a case simultaneously has been studied by the agglutination, from time to time, of the cocci both from the nasopharynx and from the cerebrospinal fluid of cases. In regard to the nasopharynx, the routine procedure followed has been to swab the cases from time to time to prevent them being discharged while carrying the meningococcus. Some convalescent cases have become chronic carriers, and all the available evidence shows that the coccus of the nasopharynx has remained of the same type as was found at the first examination. For example P_3, originally infected with Type I coccus, was found to be carrying the same organism in the nasopharynx four months from the onset of his attack. It may be added that this patient had been carrying this same type for six weeks before he was attacked by the disease which he developed in isolation.

B_2, infected by Type II, was carrying this same organism three months after the onset; and T_3 is still carrying Type II four months from the development of the disease. N_2 infected by Type IV coccus was found to be carrying this type in his nasopharynx in practically pure culture three months after the onset. Several other instances might be quoted.

In regard to the types of cocci in the cerebrospinal fluid, it is seldom that the opportunity offers for re-examining the coccus from the cerebrospinal fluid after any reasonable lapse of time from the first examination. In the case of P_3, however, where such opportunity did occur, the coccus found in the cerebrospinal fluid several weeks after the first examination was of the same type—(1) in the nasopharyngeal secretion while the patient was in isolation as a carrier; (2) in his cerebrospinal fluid when he developed the disease; and (3) in his nasopharynx at the time of the second examination of the cerebrospinal fluid.

It has been found, moreover, that when emulsions have been prepared from several single colonies of the original culture plate of the cerebrospinal fiuid that such emulsions have always, up to the present, given the same agglutination reaction.

Prevalence of Type.

There is to some extent evidence of a seasonal prevalence of type. Thus, the majority of the early cases yielded Type I. Later came Type II cases, especially among troops of the London District. In March the first Type IV case occurred, while a case of Type III did not appear until July.

Treatment.

Place of Treatment.—Owing to a special arrangement made by the D.D.M.S., cases of cerebrospinal fever occurring in the London District have been treated in special wards allotted for the purpose. This not only provided opportunity for early diagnosis, but has facilitated the application of specific treatment at the earliest possible moment, resulting in a benefit to the patients which it is difficult to over-estimate.

Mode of Treatment.—Capt. A. C. E. Gray has been in charge of the cerebrospinal fever wards, where all those suffering from the disease have been treated with anti-meningococcal serum. The degree of success which has been obtained in the treatment of cases is due in no small degree to the skill and care with which he has treated them.

In practice, Mulford's serum was found to be distinctly disappointing. The new Millbank-Lister Institute serum supplied from the Royal Army Medical College, however, has yielded exceedingly satisfactory results. This serum was prepared by Dr. MacConkey from Types I and II of the meningococci forwarded to him from the Central Laboratory as well as from other strains.

From experience gained in the course of the epidemic the routine at present is as follows: At the time of the first diagnostic lumbar puncture thirty cubic centimetres of serum are administered intrathecally, followed up on admission to the cerebrospinal fever wards by at least two further doses at intervals of twenty-four hours, no matter how great an improvement occurs after the first dose. Generally speaking, a case of average severity requires from four to six doses, very severe cases from six to ten doses, while cases which fail to improve before ten doses of serum have been administered usually prove fatal. It is well to continue the administration of serum intrathecally until the patient's temperature has been normal for at least two days.

The mortality in the London District is synopsized in the following table:—

	Total	Deaths	Percentage mortality
All cases, including those found dead or moribund	59	17	28·98
All cases treated in cerebrospinal fever wards of the London District	46	10	21·73
Cases treated with Millbank-Lister serum	43	8	18·60
Cases treated with Millbank-Lister serum; treatment began after seven days	6	3	50·00
Cases treated with Millbank-Lister serum; treatment beginning on seventh day or before	37	5	13·51
Cases treated with Millbank-Lister serum; treatment beginning on third day or before	33	3	9·09

For comparison I give the results quoted by Kutscher in his article on cerebrospinal fever, in Kolle and Wasserman's *Handbuch der pathogenen Mikro-organismen* (Second Edition). Jena, 1912. Bd. IV, pp. 589-654.

Author	Treatment begun before third day	Treatment after seventh day
	Percentage mortality	Percentage mortality
Netter	7·14	23·5
Dopter	8·20	24·1
Flexner	14·9	36·4

From the above table of London District cases it will be seen that if treatment is begun before the seventh day of the disease the mortality is 13·51 per cent, whereas if on the third day or earlier it is but 9·09 per cent. From this the importance of early diagnosis is easily seen. Several cases which have died after coming under treatment in the London District have been those in which diagnosis has been delayed. For example, in one case various tentative diagnoses were made for a month before that of cerebrospinal fever was established, the case then dying in a few days of hydrocephalus. Another fatal case was treated for ten days as influenza.

No undesirable symptoms, with the exception of a serum rash, have ever been observed from the giving of the serum in the manner recommended. No anaphylactic phenomena have been noticed in the London District.

It has sometimes been necessary to perform lumbar puncture without the advantages that obtain in a hospital ward. Under these circumstances I have found the following procedure to be helpful in securing the correct direction of the needle. After the patient has been placed on his side and the spine well flexed by pushing his head as far as possible between his knees, the site for puncture is ascertained in the usual way and the needle is pushed directly inwards through the skin between the third and fourth lumbar spaces in the middle line to a depth of about half an inch. The position of the umbilicus is now noted and the needle continued inwards in the direction of this landmark. The advantage of this procedure is that it ensures the needle being kept in the middle line after it has traversed the skin and subcutaneous tissue, thus securing uniform success of the puncture even under unfavourable circumstances.

In practically all cases a general anæsthetic is used for the lumbar puncture. The amount of cerebrospinal fluid which can be withdrawn under general anæsthesia is greatly in excess of that which can be obtained when puncture is performed without such anæsthesia. The semi-asphyxial condition due to the anæsthetic causes a rise in the cerebrospinal fluid pressure so that the fluid runs freely from the needle until 70 to 100 cubic centimetres are withdrawn. Usually no such amount can be withdrawn without general anæsthesia. For instance, in a very severe case with failing heart's action, only fifteen cubic centimetres of fluid were obtained by puncture without general anæsthesia. Two hours later, under general anæsthesia, eighty cubic centimetres were drawn off.

No untoward symptoms have followed the use of a general anæsthetic; in fact, when cases are bad, it is frequent for the patient to ask for an anæsthetic and a lumbar puncture to relieve the intense headache. A lumbar puncture under general anæsthesia is usually followed by a period of beneficial sleep and a marked improvement in the condition of the patient. On the other hand, when no general anæsthetic is used the patient awaits in a state of anxiety his next puncture.

Over and above the advice that serum should be given for at least three doses, no matter how great the improvement, it should be emphasized that serum should be persisted with in cases which improve slowly. There is but little doubt that Case 14 relapsed three times owing to the fact that serum was being given spasmodically at odd intervals and stopped too early on signs of improvement instead of being given at regular twenty-four hour intervals until improvement was well sustained. When such doses were eventually given, the case cleared up well, and was discharged within six weeks of the last dose of serum.

In some cases a lumbar puncture without serum may be required during convalescence to relieve pressure.

The following case may, perhaps, be interpreted as furnishing an indirect control of the value of the Millbank-Lister serum. A case of acute meningitis occurred recently, with polymorphonuclear cells in the exudate, which, even after six successive doses, failed to respond to the serum. Cultures from the cerebrospinal fluid in the first instance were negative, but as the case became worse a positive growth was obtained of a bacillus having the morphological and cultural characters of the influenza bacillus.

Further evidence in favour of the serum is the fact that with the earlier serum, Type IV cases did not respond so well as cases of Types I and II. With the most recent serum, in the preparation of which Type IV meningococcus has been included, the Type IV Cases (*e.g.*, Cases 50 and 57) have shown quicker improvement after the administration of serum. In the single case in which the infecting coccus has been Type III, the patient did not make such rapid progress towards recovery as was seen in the case of other patients infected by Types II and IV, and under treatment at the same time.

But perhaps the most conclusive evidence of the value of the Millbank-Lister serum is the singularly low mortality among patients to whom it has been administered in the manner described.

In cases which have improved slowly a sensitized vaccine prepared from patient's own coccus has been used. This appeared of undoubted value in Case 32, a Type IV case, the same being true of another Type IV case, treated elsewhere.

Mode of Action of the Serum.—The amount of evidence to be offered on this point is not large. In cases in which large numbers of cocci have been present in the cerebrospinal fluid at the first puncture it has been noticed that they are much diminished after the first dose of serum, and have almost disappeared after the third dose.

The serum produces a marked leucocytosis in the cerebrospinal fluid by its intrathecal injection. This has been observed both in clear fluid cerebrospinal fever cases and also in a case with clear cerebrospinal fluid which turned out not to be cerebrospinal fever.

The Influence of Age of Patient.—Although the disease generally

attacks the younger men, there is not any conclusive evidence to offer in the present series that it is more fatal to older men, since in the cases of the three men over 36 years of age who died, specific treatment was delayed for seven days or more. It appears to be the rule, however, that when attacked, older men suffer much more severely. Both the older men (Cases 42 and 58), in which treatment was begun early, recovered; indeed, both made a most remarkable recovery from a very severe attack.

Complications arising during the Course of the Disease.—Although they cannot be classed as complications it may be mentioned here that constipation was almost invariably a prominent symptom, and retention of urine not infrequent. Several of the fatal cases developed hydrocephalus. The most common complication was arthritis, which was present in four cases. This generally cleared up quite well. One case became stone deaf within forty-eight hours of onset. Conjunctivitis was present in one case, broncho-pneumonia in one, and endocarditis in another. The last case also had very marked arthritis. One case had marked weakness of the legs, which gradually disappeared. The only complication which appeared likely to be persistent in a case which recovered was a paresis of the right arm. The same case had marked nephritis during the course of the disease, with blood and sugar in the urine. The kidney trouble cleared up fairly quickly. This case was one of the early ones, and was treated with Mulford serum.

The Period from the beginning of Treatment to Convalescence.—This is the time that elapses from the beginning of treatment until the case is well enough to get up. In many cases this period has been remarkably short, even in very severe cases. It should be emphasized that the cases in the cerebrospinal fever wards are often kept in bed even until several days after they are on full diet and the patient clamouring to get up. So far as can be seen, the shortness of convalescence and the absence of ill effects on getting up must be ascribed to the mode of treatment, since it has been noticed that severe cases treated with serum in the cerebrospinal fever wards of the London District have progressed much more rapidly than somewhat apparently less severe cases which have not been treated in the same way.

Predisposing Conditions.—From the table it will be seen that several cases developed cerebrospinal fever while recovering, or just after recovering, from German measles. Three cases were under treatment for phthisis or being watched from the point of view of phthisis. Two moderately severe cases died of acute phthisis, which lit up from old tuberculous lesions during the course of the disease. Reference has already been made to a doubtful case which died of acute miliary tuberculosis.

It cannot be said that any marked relationship existed between influenza or other catarrhal conditions and cerebrospinal fever. One case had had a severe cold for a month previously, and another had been warded for influenza. As shown later, several influenzal patients were

swabbed, and in one case only was the meningococcus found in the nasopharynx.

In three cases there was evidence of the disease following upon exhaustion after heavy route marches. One of these cases was regarded as exhaustion and sunstroke for several days before the diagnosis of cerebrospinal fever was made. Since, however, many of the cases occur in recruits of but a few months' service, it may be that fatigue is to a certain extent a predisposing factor in some cases.

It cannot be said that there were many cases to be attributed to overcrowding. In one encampment ("B" depôt), in which four cases occurred, and in which very few carriers were found, it was noticed that there was a very large percentage of sore throats of streptococcal origin. There were relatively a large number of cases of German measles from this camp; and it may be that a streptococcal sore throat predisposes to the disease once the meningococcus finds lodgment in the nasopharynx, but the evidence is not sufficient to warrant more than a surmise to that effect.

The Spraying Capacity of the Patient.—It was noticed that a case which had a bad cough frequently infected more men in his surroundings than did one who had no cough. Thus the case mentioned later, where twelve men in his barrack room were found to be carriers, had been lying on his bed with a bad cough for several days before he went into hospital. He also infected patients in a ward, and a sister and an orderly in attendance upon him.

Evidence of Direct Infection of Cases from Cases.—In many cases so-called evidence of infection is capable of double interpretation. While the supposition that the first of two cases infected the second is probably in most cases true, it is sometimes possible that the first case was infected by the second while the latter was only a carrier, and that the carrier developed the disease subsequently to the case which he in reality infected.

Here are given what appear to be some instances of direct infection :—

Example I.—Case 4 (Table II, p. 18) was treated at home for fatigue and possibly sunstroke for fourteen days before a diagnosis of cerebrospinal fever was made. On the seventh day of the disease his mother, who was nursing the case, developed similar symptoms and subsequently died. From the cerebrospinal fluid of both cases the meningococcus (Type II) was grown. His brother, sister, and the man who had slept next him in his quarters were all found to be carriers of the same type of meningococcus as this case.

Example II.—Case 12 was being treated at a military hospital for German measles. In the same ward there were three other cases also convalescent from German measles. Swabs from the three men showed one man to be negative, one with a few meningococci in the nasopharynx, and the third with nearly a pure plate of meningococcus. On the fifth day, after swabbing, the last-named developed the disease. From the

cerebrospinal fluid and the nasopharynx of both cases, Type II meningococcus was grown.

Example III.—In a ward of "E" Hospital, a case of very severe cerebrospinal fever (Case 23) developed. While the ward was still in quarantine a second case occurred. This patient was in the direct line of the spray from the cough of the first patient. From the cerebrospinal fluid and the nasopharynx of the first case, Type II meningococcus was grown. A coccus of the same type was found in the nasopharynx of the second case, but could not be grown from the cerebrospinal fluid, probably because he was punctured on the first day of the disease, and after the administration of serum it is difficult to grow the meningococcus from the cerebrospinal fluid.

Example IV.—While at an isolation hospital for the purpose of swabbing a carrier, my attention was drawn to two cases of cerebrospinal fever, mother and son. The mother had been taken ill with the disease after she had been nursing her son for a few days. From the boy's throat meningococcus (Type I) was obtained, and a coccus of the same type was found in the cerebrospinal fluid of the mother.

Example V.—Case 14, P. 3, was isolated early in December from contacts of Case 2. He had been sleeping in the next bed to the case. On January 24, six weeks after being isolated, he developed the disease. The coccus from the cerebrospinal fluid of the first case was Type I. From the nasopharynx and from the cerebrospinal fluid of the second case Type I cocci were isolated. This, however, appears to be a case in which it is possible that the second case in reality infected the first case and did not develop the disease himself until six weeks later.

Example VI.—From among the contacts of a case from "A" depôt, there were isolated eight carriers of the same type as the case (Type II). One of these carriers subsequently developed the disease. After seven days his temperature suddenly went up and he manifested the symptoms of cerebrospinal fever. Despite early treatment the case died of acute phthisis which lit up from an old lesion during the course of the disease.

IV.—Positive Contacts of Cases.

The Presence of the Meningococcus in the Nasopharynx of Non-contacts from Non-epidemic Areas.

The routine procedure in connexion with the swabbing of contacts has already been outlined. By the policy of swabbing contacts of doubtful cases without awaiting a definite diagnosis, it has happened that from time to time numbers of men have been swabbed who have not been contacts of cerebrospinal meningitis. This has served the useful purpose of giving an indication of the percentage presence of the meningococcus in the nasopharynx of non-contacts. In addition, thirty-seven cases of influenza have been swabbed and are included in the figures.

Of a total of 275 non-contacts thus swabbed, six, or 2·18 per cent, were positive: one case only of influenza proved to be a carrier of the meningococcus.

Of these 275 persons examined, forty yielded Gram-negative cocci, i.e., 14·54 per cent. Particulars of these cocci are as follows :—

Result of agglutination test	Number	Percentage of number swabbed	Percentage of number agglutinated
Positive agglutination	6	2·18	15·0
Flavus agglutination	12	4·36	30·0
Group agglutination	7	2·54	17·5
Negative agglutination	15	5·45	35·5

The percentage of 2·18 agrees in the main with the result of other workers. Thus, in 1907, Hubener found eight in 400 men (two per cent).

Other similar figures for epidemic-free times are: Schumacher and Aumann (1908), just over two per cent in 1,500 soldiers; Mayer and colleagues (1909-1910), 158 in 9,111 (1·73 per cent).

During an epidemic Mayer and his colleagues found 2·46 per cent carriers among 1,911 persons who had had no demonstrable contact with the disease.

The above figures are quoted from Mayer's article in *Jahresbericht über die Ergebnisse der Immunitats-forschung*, Band vi, 1910, p. 227. Similar figures have been obtained by various other observers.

The Presence of the Meningococcus in the Nasopharynx of Non-contacts from Epidemic Areas.—Early in December a case of cerebrospinal fever occurred in one of the military offices in London. The patient had been working in a large, over-crowded room, the atmosphere of which was rendered considerably worse by the windows being closed, in order to obtain the high temperature (over 70° F.) favoured by the inmates. Only the men working in the actual vicinity of the case were swabbed at the time of the case. Since over 1,000 men were working under the above conditions, considerable anxiety was felt as regards a possible outbreak of cerebrospinal fever. Permission was therefore obtained to swab fifty men taken at haphazard from various parts of the room in order to see if there were a wide distribution of the meningococcus. Of these fifty men, seven were found to be harbouring the meningococcus. At a second swabbing, two were negative and five positive. Enquiry elicited the fact that of these five, four were recent arrivals from areas in which there had been cases of cerebrospinal fever. It was therefore decided to swab all men who had recently arrived at the office.

First were swabbed the arrivals during the past three months from "X." At "X" there had been something in the nature of an epidemic. From sixty-two men five positive carriers were obtained.

Next were swabbed the arrivals from "Y." Fifty-five men were

swabbed and four carriers found. At "Y" at the time there was a more localized epidemic than at "X."

After removal of these carriers another sample of men was taken at random from the office. Now from fifty-two men swabbed only one carrier was found, who cleared up almost at once.

These results are tabulated below:—

—	Number of cases in which cocci were agglutinated	Number positive	Number showing flavus agglutination	Number showing group agglutination	Number showing negative agglutination
Sample 50 men swabbed ..	13	7	0	1	5
62 new men from X ..	14	5	0	2	7
55 ,, ,, Y ..	12	4	3	1	4
52 sample of remainder ..	4	1	2	0	1

From another office four carriers were isolated from sixty-five men.

In view of these results it was suggested to the authorities that all men should be swabbed who entered the office from epidemic areas. This offer was gladly accepted. Indeed, since that time, every man entering the office has been swabbed whether from an epidemic area or not. This has necessitated the swabbing till the end of July of 832 men. Of these, forty-one have been found to be carriers. This is 4·93 per cent of the men swabbed.

The agglutination test was deemed necessary in 205 cases. The results may be tabulated as follows:—

	Number	Percentage of total swabbed	Percentage of cocci agglutinated
Positive agglutination ..	41	4·93	20·00
Flavus agglutination.. ..	34	4·08	16·58
Group agglutination	29	3·48	14·14
Negative agglutination ..	101	12·13	49·26

Analysis of the figures as to the place from which the men came gives the following results:—

—	Number swabbed	Number positive	Per cent	Types I	Types II	Types III
"Y" area	460	24	5·22	7	17	..
"X" area	191	12	6·27	7	4	1
"Z" area	126	4	3·17	2	2	..
Other places	55	1	1·81	1	..	..

It is of interest to note that so recently as the beginning of July twenty-six men arrived from "X" and were swabbed. These men had not

been at " X " during the time of the epidemic, having arrived but two or three months ago from overseas. They had, however, mixed freely with men who had been at " X " during the time of the epidemic. From these men three carriers were isolated.

The swabs of twenty-two men from " X " area are of interest. These were taken from men who had arrived but ten days before from overseas. Two of them were found to be positive, possibly indicating that they had brought the meningococcus to this country with them.

Percentage of Positive Contacts among Contacts of Cerebrospinal Fever Cases in the London District.

In connexion with the sixty cases of cerebrospinal fever occurring in the London District, 1,629 contacts were swabbed. In this number are included the contacts of a case taken ill while on leave at Bristol and treated there. Of the 1,629 contacts swabbed, 139, or 8·53 per cent, were found to be positive.

For arriving at this result, the agglutination test was necessary in 331 cases, with the following results tabulated below :—

—	—	Per cent of total swabbed	Per cent of total agglutination
Positive agglutination	139	8·53	42·00
Flavus agglutination	48	2·94	14·50
Group agglutination	42	2·57	12·68
Negative agglutination..	102	6·26	30·82

Since a considerable number of cases occurred among men from other commands, it frequently happened that the number of contacts in the London District was not large; most of the contacts being in another command. For this reason the contacts are best viewed in accordance with the grouping of the cases given previously, viz., London District troops and other commands. In connexion with a case among London District troops, both troops and hospital contacts are swabbed. In connexion with a case from an outside command passing through London or on leave there, the contacts are generally hospital or other contacts who have been but a short time in contact with the case.

The results of the swabbing are seen in the following table :—

—	Number swabbed	Number positive	Per-centage
London District (regimental contacts)	774	85	10·98
London District (hospital contacts)	367	27	7·16
Outside commands (hospital and other contacts)	488	27	5·53

It will be seen that the percentage of contacts is distinctly higher among troop contacts than among the hospital or other contacts, indicating

that the disease is best combated by swabbing among the troops. The percentage of hospital contacts among London District cases is markedly increased by the inclusion of a number of carriers who were probably infected by a carrier nurse. In a ward of thirty-one men, eight positive contacts were found, five of whom were of different type from the case, but of the same type as the carrier nurse.

In regard to housing during the winter season, the troops have been chiefly living in huts, barrack rooms or billets. With troops in billets, the spread of the disease is limited, but in two cases room mates have been found to be positive carriers. It is not possible to draw any marked distinction between rooms and huts, although the greatest number of carriers was found in a barrack room, where twelve men out of thirty-one were found to be positive. This case well illustrates the correspondence of type of the coccus among case and carriers. The case was that of B_2, and was the first to occur in "A" Depôt. From the cerebrospinal fluid of the case and the nasopharynx a coccus of Type II was isolated. Of the thirty-one men of the barrack room, twenty-one had Gram-negative cocci in the nasopharynx, and the agglutination test resulted as follows:—

TABLE SHOWING THE RESULT OF AGGLUTINATION TEST UPON THE COCCI OF THE CEREBROSPINAL FLUID AND THE NASOPHARYNGEAL SWAB OF THE CASE AND OF GRAM-NEGATIVE COCCI FOUND IN THE NASOPHARYNX OF TWENTY-ONE ROOM MATES.

Cocci	Normal serum	Serum I			Normal serum	Serum II		
	1/100	1/100	1/200	1/400	1/100	1/100	1/200	1/400
Standard cocci *v.* sera ..	—	+ +	+ +	+	—	+ +	+ +	+ +
(Case) B_2 C.S. F. ..	—	—	—	—		+ +	+ +	+ +
(Case) B_2 swab	—	—	—	—		+ +	+ +	+ +
G. 1 Pte. W. G. O. ..	—	+ +	(+)	—		+ +	(+)	—
G. 2 Pte. L. J. S. ..	—	—	—	—		+ +	+ +	+ +
G. 3 Pte. W. T. S. ..	—	(+)	—	—		+ +	+ +	+ +
G. 6 Pte. G. H. ..	—	—	—	—		+ +	+ +	+ +
G. 7 Pte. W. H. ..	—	—	—	—		+ +	+ +	+ +
G. 8 Pte. G. B. ..	—	—	—	—		—	—	—
G. 9 Pte. G. L. ..	—	—	—	—		—	—	—
G. 10 Pte. W. S. ..	—	—	—	—		+ +	+ +	+ +
G. 11 Pte. W. F. ..	—	—	—	—		—	—	—
G. 12 Pte. J. C. ..	—	—	—	—		—	—	—
G. 14 Pte. A. W. ..	—	—	—	—		+ +	+ +	+ +
G. 17 Pte. W. B. ..	—	—	—	—		+ +	+ +	+ +
G. 18 Pte. W. S_2. ..	—	—	—	—		+ +	+ +	+ +
G. 20 Pte. W. R. ..	—	—	—	—		—	—	—
G. 21 Pte. R. G. ..	—	—	—	—		+ +	+ +	+ +
G. 22 Pte. S. P. W. ..	—	—	—	—		+ +	+ +	+ +
G. 25 Pte. H.	—	—	—	—		+ +	+ +	+ +
G. 26 Pte. B.	—	—	—	—		+ +	+ +	+ +
G. 28 Pte. J. L. M. ..	+ +	+ +	+ +	(+)		+ +	+ +	+ +
G. 29 Pte. R. T. ..	—	—	—	—		—	—	—
G. 31 Pte. N.	—	—	—	—		—	—	—

The above table shows that of the twenty-one cocci agglutinated, twelve yielded positive results, the coccus in every case being Type II.

In all, fourteen ward contacts of the case were swabbed. Of these it was necessary to agglutinate the cocci of six. Two of these yielded positive results, both of the same type as the case.

Seventeen members of the nursing staff and orderly staff were swabbed. Of these, the cocci of three were submitted to the agglutination test, two being positive (Type II).

TABLE SHOWING TYPE OF COCCUS IN CARRIER AND POSITIVE CONTACTS.

Case	Type	Number of contacts swabbed	Number of positive contacts	Type of positive contacts
1	?	8	3	I
2	I	16	1	I
12	II	63	4	${}_{3}$II ; ${}_{1}$I
13	II	91	2	II
15	I	44	2	${}_{1}$I ; ${}_{1}$II
16	II	13	1	II
17	II	113	24	II
18	II	15	1	II
19	II	30	4	II
21	II	91	10	II
22	IV	29	2	${}_{1}$II ; ${}_{1}$IV
23	II	26	3	II
24	?	74	9	II
25	II	51	3	II
26	II	23	2	II
29	I	12	5	${}_{1}$I ; ${}_{4}$II
30	II	38	8	II
31	II	17	1	II
32	IV	26	2	${}_{1}$I ; ${}_{1}$IV
36	II	23	1	II
40	II	39	8	${}_{4}$II ; ${}_{4}$I
41	II	54	8	${}_{7}$II ; ${}_{1}$I
43	I	49	8	${}_{2}$I ; ${}_{6}$II
44	I	30	5	${}_{3}$I ; ${}_{2}$II
45	II	60	3	${}_{1}$II ; ${}_{2}$I
46	II	55	3	${}_{2}$II ; ${}_{1}$I
49	II	19	2	II
51	II	3	1	II
53	?	40	5	${}_{4}$II ; ${}_{1}$IV
54	II	35	4	${}_{3}$II ; ${}_{1}$I
56	II	10	1	II

Owing to the high percentage of positive contacts in the barrack room it was deemed necessary to swab any intimate friends of these men. Two such friends, Privates P_1 and P_2, were discovered and found positive (Type II). It was therefore considered advisable to swab the room mates of both these men. From Pte. P_2's room, twenty-seven men were swabbed. Of these the cocci of six were agglutinated and two found positive. From Pte. P_1's room twenty-two men were swabbed. Four were agglutinated and found to be positive (Type II). In addition,

the serjeant who was placed in charge of the isolation huts where the men were segregated pending investigation of the swabs was eventually found to be positive, although a previous swab had been negative. It will be seen that, in all, twenty-four positive contacts were found, all giving the same type of meningococcus as the case.

The correspondence of type between case and carrier may be further illustrated by a table showing the type of coccus of case and carrier in all cases where positive carriers have been found. This is given in the table on page 136.

It will be seen that among the 119 positive contacts of cases in which the type of coccus was known, ninety-four were of the same type as the case. Most of the carriers of a different type of coccus were found in connexion with the later cases. In some instances, as mentioned above, there is evidence of a dissemination of the meningococcus among the contacts by a carrier of a type different from that present in the case.

In order to compare the distribution of types of meningococcus in cases and those in contact with them at the time when they were taken ill, it is necessary to deal exclusively with the sixteen cases that actually contracted cerebrospinal fever while they were stationed in the London area. Details with regard to the types of meningococcus found in these sixteen cases and their contacts respectively are as follows :—

	Type I	Type II	Type III	Type IV
Cases	2	13	—	1
Positive contacts	13	78	—	1

The correspondence of type revealed by this table is striking.

The constancy of type in one locality is also noticeable. All the seven cases from "A" Depôt were Type II. From these cases fifty-four positive contacts of the same type were isolated. Among the contacts of one of the later cases four Type I carriers were found ; three of these cleared up pending investigation of the first swabs, showing that they may have been recently infected by the fourth man who had probably brought the type from elsewhere.

Evidence of Infection of Cases by Carriers.

Evidence of infection by carriers is difficult to obtain, since it is seldom that a person is proved to be a carrier before he is examined in connexion with a case with which he has been in contact. The following instances, however, are instructive.

I.—Sapper Bs. returned from France on April 9, 1916, and had been complaining of headache and pains in the back and legs, while in the trenches a few days previously. There is no evidence that he had had any meningitis. Two days after his arrival one of his children was taken ill and removed to a general hospital with symptoms of cerebrospinal meningitis. Next day another child was taken ill and removed to an

isolation hospital, where he died of the disease. The father was now isolated, and found to be a carrier of Type II meningococcus. A few days after removal, the first child was discharged after what was termed "an abortive attack" of cerebrospinal meningitis. He was fetched by his sister on the Thursday. Up till then the sister had been quite well. She did not subsequently see her father at close quarters, but on the following Sunday she was taken ill in the morning, and died within twenty-four hours. A swab from the child having the abortive attack showed the presence of the Type II meningococcus in the nasopharynx.

There had been no cerebrospinal fever in the borough for eighteen months until these cases occurred.

II.—Private P., A.S.C., returned from France on leave on July 18. On July 27 one of his children was taken ill and died the next day of cerebrospinal fever. A swab from P. gave a plate showing many colonies of meningococcus (Type IV). His other three children were subsequently removed to a fever hospital. One child was suffering from pyrexia, with a temperature of 101° F., but no marked meningitic symptoms. The cerebrospinal fluid showed no cocci or increased cell content. From the fluid of a swollen knee-joint, however, the meningococcus was grown (Type IV). This appears to be an example of infection of the knee-joint without involvement of the meninges. A blood culture, taken one day after the knee had swollen, proved sterile.

III.—Case 54 developed the disease at H. Military Hospital after he had been in there for two months on account of an accident. Of the four positive contacts, three were of the same type as the case. Two of these were in the beds on either side of the case, and the other was the staff nurse of the ward. All the available evidence went to show that the nurse was a chronic carrier, and inquiry revealed the fact that she had started nursing in the ward within two months, and had been nursing several cases of meningitis a year before and had not been swabbed subsequently. It seems probable that the case was infected by this staff nurse. The two other positive contacts cleared up quickly; the nurse is still a carrier.

From time to time various men from other commands whose children have contracted the disease have been swabbed in the London District Laboratory. Five of these have proved positive carriers. In two cases the child developed the disease soon after the arrival home of the father. The evidence of infection is, however, only of a suggestive nature.

The Development of the Disease by Carriers while in Isolation.

Reference has already been made to several carriers who developed the disease after being in isolation. In the London District, four such cases have occurred, one after six weeks, and three after five to ten days.

One other case, a contact, developed the disease while his swab was being investigated. One hundred and eighty-five men were treated in the carrier wards.

Evidence of the Proximity of Positive Contact to Patient.

Generally speaking the positive carrier is found to be in close proximity to the patient. This is especially the case when the number of positive carriers is small. When the number is large, as in the case of the barrack room already quoted, then the probability is that many of the positive contacts isolated are infected only indirectly by the case. Several examples of such propinquity have already been given, in the evidence above, of contacts who have subsequently developed the disease. Other examples may also be cited:—

(1) In connexion with Case I, the three positive contacts were as follows:—

(*a*) The man who occupied the same bedroom at the billet.

(*b*) The man who sat next the case at the office.

(*c*) A great friend of the case who was often in his company.

(2) The positive contact of Case 15, of the same type as the case, slept exactly opposite him in the ward. The contact was a phthisical subject who eventually died of that disease (phthisis). It was found impossible to clear up his nasopharynx in twenty weeks, and it is quite probable that since he had a distressing cough he may have infected the case, who did not develop the disease until three weeks after admission to hospital. The other positive contact of a different type was not in the ward at the same time as the case, but since he entered the ward on the evening of the day the case was isolated he was swabbed with the rest of the ward.

(3) The positive contact of Case 16 was in the next bed in the ward.

(4) The positive contacts of Case 19 were as follows:—

(*a*) The man who slept next to him in his bedroom.

(*b*) The man who slept exactly opposite to him.

(*c*) The orderly in attendance on the case before it was removed to hospital.

(5) Of the two positive contacts of Case 22, the one who had the same type of coccus as the case was the only man who had slept in the same hut at L. He also saw a good deal of the case in the train to London. The other man of different type had no contact beyond sleeping in the same hut one night, and then several beds away from the case.

(6) The contact of Case 31 was a friend of the case, helped him when he was ill and slept next to him.

(7) Of the two contacts of Case 32, one slept exactly opposite in the bedroom, the other took him eighteen miles in an ambulance to hospital. It is probable that this case had both Types I and IV in the nasopharynx.

(8) The two positive contacts of Case 49, who was treated for ten days as influenza, were the patient in the next bed but one, and one of the orderlies in attendance on the case.

(9) The positive contact of Case 51 was the patient's brother.

(10) Among the carriers regarded as positive contacts of Case 53, who was treated for over three weeks in a ward as a case of acute rheumatism, were the staff sister of the ward and the two men just opposite in beds on the other side of the ward. Two others yielding the same type as the case occupied the same billet, one the same bedroom with the case before he first went to hospital.

(11) The positive contact of Case 56 was in the same ward, at right angles to the bed of the patient.

Evidence of Dissemination of the Coccus by Carriers.

Over and above the evidence of infection already given other examples may be quoted:—

Of the eight positive contacts of Case 43, only two were of the same type as the case and were in close proximity to the patient. The other six carriers were of different type. The probable explanation is as follows: One of these six cases was a nurse in the ward, who, according to her statement, attended to the dressings, etc., required by the other carriers of this type. It would seem to be the fact that the nurse in question helped to spread this type round the ward.

The four contacts of different type from Case 29 were all together in a part of the ward farthest from the case: one carrier among them probably infected the others. One of these men subsequently developed the disease after isolation in the carrier wards. The contact who yielded the same type as the case slept in the next bed to the case.

Evidence of Cross Infection among Segregated Carriers.

There is but little evidence of cross infection. The coccus of all carriers of long duration has been agglutinated from time to time during their stay in hospital. It has been found that the type of coccus with one exception remained unaltered.

There have been more carriers of Type II meningococcus than of any other type. With one exception it has been found that carriers of this type have retained Type II coccus in the nasopharynx. A carrier of Type I who was warded almost exclusively with many Type II carriers retained Type I coccus over a period of eighteen weeks. At one period a carrier of Type IV coccus was for twelve weeks with sixty to eighty carriers of Types I and II. At the end of twelve weeks his coccus, however, was still Type IV. The first carrier of Type III coccus was found to still have Type III in the nasopharynx at the second agglutination three weeks later, although all the other carriers were harbouring a different type of coccus.

The conditions in hospital where the wards are well ventilated and the beds far apart are such that the danger of cross infection by carriers is small.

The above-mentioned exception is of interest. The case was a carrier of Type II coccus, and had had one negative swab. Then he took to his bed with signs of meningitis, and it was a question as to whether he should be lumbar punctured or not. It was, however, decided to wait, a swab only being taken. The symptoms speedily subsided. From the swab Type I coccus was grown, which he harboured until he proceeded to a convalescent hospital.

Meningismus among Carriers.

Several other cases of slight meningismus have been noticed among carriers, that is to say, cases who have complained of severe headache, pains in the back of the neck and generally in the back also. There is no vomiting, usually some pyrexia (100° to 102°), and a slight Kernig may be present. A swab is taken which shows the presence of the meningococcus, but inquiry next day elicits the fact that the case is much better, or practically well.

Such a case occurred in regard to a Hebrew member of the Royal Flying Corps. This man had been in contact for a few hours with a case of cerebrospinal fever (Type IV) which had died in under twenty-four hours. He was swabbed and found to be negative. The circumstance, however, preyed on his mind. A month later he went to a military hospital complaining of his head, neck, and back, and stating that he had been in contact with cerebrospinal fever. A swab taken revealed the presence of the meningococcus, but not of the type of the case with which he had been in contact.

A case of suspected cerebrospinal fever was sent from a military hospital to a Metropolitan Asylums Board hospital as (?) cerebrospinal fever. The Metropolitan Asylums Board medical officer regarded the case as certainly not cerebrospinal fever, since there appeared to be little the matter with the man; on the other hand, the military medical officer had noticed distinct meningitic symptoms. A swab from the nasopharynx of the case showed an almost pure plate of meningococcus (Type II). In the fluid from a lumbar puncture no evidence of meningitis was found.

Other cases of similar nature have been seen. It should be noted, however, that such symptoms also accord with other febrile conditions; by far the greater number of cases, complaining of headache with slight stiff neck, and sometimes slight Kernig's sign, are of "influenzal" nature. From such the meningococcus is, in my experience, obtained neither from the cerebrospinal fluid when the case is punctured nor from the nasopharynx. In such cases the cerebrospinal fluid is quite clear, with no

signs of cocci or polymorphonuclear leucocytes or other meningitic manifestations.

Other carriers occasionally complain of headache, which may or may not be connected with the presence of the meningococcus in the nasopharynx.

The Influence of Nasopharyngeal Catarrh.

It cannot be said that the carriers exhibited any marked nasopharyngeal catarrh; generally speaking it was found to be absent. When tonsillitis was present, it was found in several cases investigated not to be of meningococcal origin. One point, however, deserves mention. It was noticed that, although nasopharyngeal catarrh was not caused by the meningococcus, carriers who suffered from tonsillitis or pharyngeal inflammation were much more difficult to free from the meningococcus, and many carriers of more than six or eight weeks' duration have had some tonsillitis. The same is true of convalescent cases. At the time of writing several cases who have long been ready for discharge are suffering from inflamed tonsils and still retain the meningococcus in the nasopharynx.

Mode of Plating Swabs.

The importance of plating swabs on the spot, and of carrying the plates in warmed tins, is shown by the following observations:—

On March 4, 1916, thirty-two carriers were swabbed and the swabs carried to the laboratory by motor-car and plated there. The day was cold, and probably about one hour elapsed from the beginning of swabbing to the time of plating. Of the swabs thus taken twenty were negative. Three days later the men were again swabbed and the swabs were plated on the spot. As a result all save three were positive. A few days later the swabs were again taken to the laboratory before plating, and of twenty-eight swabs taken twenty-three were negative.

As a further experiment, forty-two carriers were swabbed and the swabs conveyed in a heated tin with the lid off. Of the swabs, thirty-seven were negative. Two days after, swabs were again taken and plated on the spot; twenty-four of the men previously found negative were now found to be positive.

From this it would appear that the only satisfactory method of swabbing is to plate on the spot and carry the plates in water-jacketed tins warmed to about 37° C.

The Average Duration of Carrying by Carriers.

In the London District 185 carriers were isolated. Of these, 124 may be said to be contact carriers and 61 to be "non-contact carriers." By "non-contact carrier" is meant one who was not swabbed because of actual known contact with a case of cerebrospinal fever, or one having

been swabbed in connexion with a case who has proved to be a carrier of a different type of coccus from the case. The majority of non-contact carriers were swabbed previous to admission to an Army Pay Office. The average time of isolation for 124 true contacts was 4·65 weeks, and for 61 non-contact carriers 3·68 weeks. The length of stay of carriers is seen in the following table :—

—	Contact	Per cent	Non-contact carriers	Per cent
Under 2 weeks..	20	16·12	12	19·67
2—4 weeks	45	36·29	32	52·46
4—6 weeks	26	20·97	5	8·19
6—8 weeks	14	11·29	2	3·28
8—10 weeks	4	3·23	7	11·48
10—12 weeks	5	4·03	—	—
Over 12 weeks	10	8·07	3	4·92

The percentage of carriers of more than four weeks' duration is 47·59 per cent in the case of 124 true contacts, and 27·77 per cent in the case of 61 non-contact carriers. On comparing the duration of carrying of each type no evidence has been found to indicate that any one type of meningococcus persists longer in the nasopharynx than another.

Rate of Discharge of Carriers in Different Months.

Meteorological Conditions.

It was not until the month of March that the carriers became sufficiently numerous to warrant any deductions as to the relationship of the rate of discharge to meteorological conditions. The impression obtained at the time was that whatever the form of treatment a spell of sunshine and dry weather markedly influenced the rate of discharge of carriers. Thus it was noticeable that in the dull weather of February and March the rate of discharge was slow, whereas, particularly with the fine weather at the beginning of April, the rate of discharge was rapid. It was also noticeable that during this spell of fine weather, carriers who had been in isolation during most of February and March cleared up and were discharged. In the following table is given for the months of February, March, April and May—

(*a*) The number of carriers in isolation.
(*b*) The number discharged each week.
(*c*) The mean maximum weekly temperature.
(*d*) The mean minimum weekly temperature.
(*e*) The rainfall in inches for each week.
(*f*) The average amount in hours per day of bright sunshine.

Week ending	Number of carriers in isolation	Number discharged	Mean maximum temperature	Mean minimum temperature	Rainfall in inches	Bright sunshine, hours per day
Feb. 5	8	—	46·2	39·6	0·53	1·6
,, 12	14	1	45·3	35·2	0·41	3·9
,, 19	17	1	50·9	37·0	1·02	3·8
,, 26	23	1	37·18	30·7	0·79	0·9
March 4	29	5	41·20	32·2	0·60	1·6
,, 11	49	8	39·00	30·9	0·61	1·4
,, 18	54	1	49·3	40·1	0·82	0·5
,, 25	60	3	46·0	35·1	1·06	1·8
April 1	85	2	48·7	33·4	1·21	4·9
,, 8	80	19	53·2	36·5	0·25	6·4
,, 15	67	20	54·0	39·0	0·26	6·9
,, 22	43	11	51·6	40·3	0·51	2·4
,, 29	50	4	65·7	45·1	—	8·0
May 6	54	16	63·9	46·9	0·74	3·7
,, 13	38	7	56·3	44·1	0·77	1·9
,, 20	36	—	68·4	47·8	0·08	8·5
,, 27	42	19	68·9	48·7	0·04	8·3

It will be seen that following a week of sunshine, with little rain, the number of discharges is greatly increased.

Treatment.

Various forms of treatment with nasal sprays and douches were tried, but it cannot be said that any one form of treatment was especially efficacious. Among the various formulæ employed were :—

(i) The iodine and menthol spray recommended in the War Office memorandum.

(ii) Eusol.

(iii) Chlorine water (potassium chlorate, ten grains; hydrochloric acid, strong, two minims; water, to one ounce.

(iv) Chloramine solution, one to two per cent.

The first form of treatment was persisted in the longest, and was employed when the meteorological conditions seemed least favourable, namely, in February and March.

Chloramine appeared to be the most efficacious form of treatment, but the evidence is by no means conclusive since the meteorological conditions at the time (April) were such that carriers on the iodine and menthol treatment were also clearing up. It should be noted, however, that the carriers who cleared up with chloramine were of longer duration than those who cleared up at the same time with iodine.

Further observations are required with a control batch of carriers having no treatment save a saline douche to wash out the nose.

More recently an attempt has been made in conjunction with Lieutenant-Colonel Gordon to rid the nasopharynx by exposing the carrier to an atmosphere impregnated with a disinfecting agent by means of an automatic steam spray. These results are dealt with elsewhere.—(*Brit. Med. Journ.*, November 18, 1916.)

On the Value of Swabbing for Limiting the Spread of Cerebrospinal Fever.

The following instance, which is within my own experience, and relates to an important depot, may be given for the purpose of calling attention to the preventive value of swabbing widely at the beginning of an outbreak, using the type of meningococcus as guide.

The depot in question serves as a collecting station where recruits to the several regiments served by it are trained before joining their units which are located in four large barracks, situated elsewhere.

During the outbreak of 1915, nineteen cases of cerebrospinal fever occurred at the depot in question with eleven deaths; and manifestation of this disease at the depot was followed by its appearance at all of these barracks and also at a temporary camp among men who had moved in from the depot.

In February, 1916, cerebrospinal fever reappeared at the depot, and between February and April seven cases occurred. All of these seven cases were found to be infected by the same type of meningococcus (Type II). All of them were treated by anti-meningococcus serum supplied from the Royal Army Medical College, and all recovered. The point in question in the present instance, however, is the value of swabbing for preventing the spread of cerebrospinal fever. When the first case occurred at this depot in 1916, not only contacts of the case were swabbed, i.e., room-mates and personal friends, but also contacts of those found positive, and again contacts of the carriers thus discovered. In this way 113 men were swabbed in connexion with the first case, with the result that twenty-four carriers were found, all yielding Type II meningococcus. In connexion with the second case, ninety-one men were swabbed, of which ten were positive, all again yielding Type II. In connexion with the third case, fifty-one men were swabbed, with the result that two of them were found positive, and as before both carried Type II. These figures may be tabulated as follows:—

Case	Men swabbed	Men positive	Percentage positive
1	113	24	21
2	91	10	10
3	51	2	4

These carriers of the particular meningococcus locally operating were isolated forthwith. Now it is noteworthy that although during the 1916 season this depot was continually supplying the four barracks with men, no cases of cerebrospinal fever occurred in the barracks in question. In view of this result, it may reasonably be claimed that the wide swabbing practised on the appearance of cerebrospinal fever, and the early elimination of carriers of the active organism at this depot, checked the spread of the disease.

Review.

WHEN TO ADVISE OPERATION IN GENERAL PRACTICE. By A. Rendle Short, F.R.C.S. Bristol: John Wright and Sons. Pp. 266. Price 5s. net.

In this book "an attempt is made to set forth fully, yet concisely, indications for operation in ordinary cases, excluding anomalies and rarities."

It is probable that practitioners have felt the need of some such means of discovering what is best to be done for their patients, and the volume under review would appear to furnish what is wanted in a handy and compact form, easily read and easily referred to; for although its arrangement is quite arbitrary, it proves to be quite a good arrangement when put to the crucial test of seeking for special guidance in a few specimen cases taken at random.

The classification is chiefly anatomical, but subsections are devoted to symptoms, so that the reader may find valuable help irrespective of whether he is able fully to diagnose his case or is able merely to determine one or more of the leading symptoms.

The indications for and against operation follow sound and well-established lines, but none the less the author has contrived to infuse a certain originality and pleasant dogmatism without too much of the surgical ego. There are a few points to which many surgeons will take exception. For instance, the author seems to have had the remarkable experience of discovering the actinomyces as the cause of appendicitis in no less than one to two per cent of his cases. Few surgeons see cases of streptothricial appendicitis with anything like this frequency. Again, on page 262 the author advises against operation for traumatic rupture of the intestine when more than twenty-four hours have elapsed since the injury. It is true that the prognosis of laparotomy at this late stage is very bad, but it is not hopeless.

Those who have seen much of the surgery of children's diseases will dissent from the suggestion that acute retropharyngeal abscesses should be opened from the neck. Most surgeons find it much simpler, quicker, and safer to open them in the pharynx.

It is interesting to find that the author is one of those who find that partial operation in incurable cases of cancer of the tongue has an occasional but legitimate field of usefulness in ridding the patient of some of the more dreadful symptoms of this hopeless disease.

The volume may be recommended, not only to the general practitioner, but to the occasional operator whose opportunities of surgical practice are more or less limited. C. R.

Correspondence.

THE IRRITATING SUPPLICATIVE.

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—I ask for space to protest against the excessive and senseless use of the supplicative "Please," which has crept into our present day official correspondence. Each day brings to my office a series of minutes all sprinkled freely with this word. Its use is obviously legitimate and proper when expressing a request, but it is difficult to justify its use in connexion with mere statements of fact. "For your information, please," or "Captain Jones proceeded to —— on December 2, please," are common instances of the misuse of the word. To-day, this gem arrived, "This is not a difficult matter in the case of a Division, please." I hope that I am not a crank, but I do think that officers who sign minutes have a definite responsibility that the communications to which they subscribe are couched in logical and correct phraseology. In many cases, the introduction of the word "please" makes the sentence in which it occurs to be quite without sense. With apologies to "Mr. Punch," who has protested on similar lines against the overworked imperative "must," I would express my views as to the supplicative "please" in the following verses.

There are various words much in need of a rest,
They've been horribly hackneyed, remorselessly stressed;
But there's one that's so worn that it's bare to the knees,
'Tis the sadly misused monosyllable "please."

It's the pet of the clerk, that slave of the office
Who uses the word without thought or real malice;
And there's never a day we're not fretted and teazed
By some foolish request that we deign to be "pleased."

Supplications addressed by the wisest or sane
Don't always appeal to the average brain;
But it makes my feet cold till I'm ready to sneeze
When statements of fact always end with a "please."

Official correspondence often excites
Words of critical remarks more frank than polite;
But writers of minutes would give us more ease,
If they strictly tabooed this provocative "please."

I am, etc.,

December 10, 1916. R. H. FIRTH, *Colonel.*

DENTAL TREATMENT IN THE ARMY.

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

SIR,—An important aspect of Army Dental work does not appear to have received the attention it merits. I refer to the modifications of dental treatment that have been the result of experience in the treatment of troops.

All of us, commissioned dental officers and civilian dental surgeons,

commenced our work with the idea that every savable tooth should be filled, and every unsavable tooth should be extracted and, if necessary, dentures provided to fill the gaps; some of us even went so far as to extract on a large scale for the cure of pyorrhœa.

At the present time the views of the authorities are clearly laid down and it is for us to give effect to the instructions in the most intelligent manner we can. The latest instruction points out that stumps are often more useful than dentures. It is stated that only efficient mastication is necessary, but it is not always easy to decide what constitutes efficient mastication. Further, we are told to pay more attention to the cleaning of mouths, but according to our preconceived ideas this constitutes extraction in preparation for dentures in most cases.

My experience has led me to adopt certain principles which I believe are in accordance with the views of the authorities and which may be of interest.

(1) *Scalings.*—Every scaling is necessary. The reason is not so much a surgical as a military one. The soldier is taught habits of cleanliness and the cleaning of his teeth is one of the most important. He cannot keep his teeth clean if they require scaling, and therefore, apart from the surgical aspect, scaling is a necessity. There is reason to believe that scaling is appreciated by the majority and that it is the foundation of regular habits of cleanliness.

(2) *Fillings.*—It soon becomes clear in treating soldiers that to fill every savable tooth is unnecessary, even if it were possible. When, however, the soldier has lost so many teeth that further extraction would render dentures necessary, any cavities that exist must be filled.

Sometimes it is possible to select one side of a man's mouth for filling, and give the soldier a comfortable masticating surface; the other side can then be entirely neglected. It is very important to fill teeth supporting dentures. I have been impressed by the large number of teeth in which the caries has become naturally arrested, and advantage of this tendency can often be taken.

(3) *Extraction.*—In examining, it becomes apparent that there are large numbers of useless stumps whose removal would still leave efficient mastication. A feeling of dissatisfaction is created in the mind of the soldier by the extraction of such stumps, because he thinks he is entitled to have them replaced. It should always be explained, therefore, that substitutes will not be allowed, and the soldier will usually prefer to leave the stumps until they give him trouble. In cases, however, where there are symptoms of general ill-health probably caused by oral sepsis, such extraction has to be insisted upon.

Extraction in preparation for dentures forms the greater part of our operative work and is by far the most important part of our work. It is to be regretted that in so large a proportion of cases the teeth are beyond saving. Such, however, is the case and we are faced with the problem.

as to whether the teeth must be extracted and dentures provided, or the soldier allowed to continue using his stumps for mastication.

It is impossible to lay down a sweeping rule and each case has to be judged on its merits.

The following points concerning dentures have to be considered. I am aware that they are not in accordance with text-book reading, but from a military point of view I am convinced of their soundness.

(*a*) As a mechanical contrivance dentures are inferior to stumps, provided the stumps are not tender.

(*b*) From a surgical point of view dentures are a greater abomination than stumps, under active service conditions, unless there is some incentive for the soldier to keep his dentures clean. It must be borne in mind that the soldier under fire lives in a state of tension, his daily habit of cleaning his teeth tends to be neglected. Even officers neglect their teeth-cleaning, sometimes because clean water is scarce but generally because they forget.

If we could follow the men for whom we have provided dentures out to the Front a fortnight later, and could examine their dentures, in a large percentage of cases we should find the dentures in a far more septic condition than the original stumps. Even in the training camps at home, my experience shows that the men with dirty tongues and offensive breath are the men who wear dentures, whilst the men with stumps have clean tongues and breath.

The soldiers who take care of their dentures at the Front are invariably those who have reason to be grateful for the provision on account of improved health and greater comfort.

(*c*) Dentures are liable to be broken or lost, the gums may shrink and the dentures become loose, and the loss of a tooth supporting a denture may render the denture useless. In any of these circumstances, a visit to a base at the public expense is necessary, besides the loss of a fighting unit for a week or two.

The vast majority of men whose teeth are mostly stumps are enjoying good health. A parade of a large number of such cases leaves no doubt. In civil life under the social conditions that existed before the War, their daily occupations tended to lower their resistance. When they enter the Army their habits of life become regular, in most cases they are better clothed and fed than ever before, and they are put through a graduated course of training and exercise, especially designed to make them fit. Surely if they enjoyed good health before, they will do so now. Their dental condition was neglected before, and now if the mouths are scaled and cleaned the habit of the tooth brush acquired, and essential teeth carefully filled, nothing more is needed to ensure continued health in the vast majority of cases.

There remains, however, a proportion of cases whose dental condition is responsible for ill-health in one form or another. Such men are classed

as category "A," which does not mean they are physically fit for the Front at the time of enlistment, but that they are likely to become fit as a result of the training. Some of them become fit in spite of their dental condition, but for most of them dental treatment is absolutely necessary.

It is therefore essential that the Dental Surgeon should see the men when they are first drafted to the training centre, so that, in consultation with the Medical Officer, the history of each case can be gone through where the teeth are mostly stumps, and it can be decided as to what extent the condition has affected the general health, whether the training is likely to eliminate the symptoms, or whether extraction in preparation for dentures would not only be genuinely appreciated by the soldier himself, but would be the determining factor as to whether or not he would ultimately become fit for the Front.

I am, etc.,

23, Brunswick Square, Hove. W. L. Cocker, *Captain.*
November 21, 1916.

TREATMENT OF SEPTIC GUNSHOT WOUNDS.

TO THE EDITOR OF "THE JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

Dear Sir,—I should be greatly obliged if you would kindly publish the following note in the Journal:—

I take this opportunity to bring to the notice of officers of the Royal Army Medical Corps who are interested in the treatment of septic gunshot wounds with Ichthyol and glycerine, the importance of substituting Subitol for Ichthyol on the grounds of expense and the present difficulty of obtaining Ichthyol. Subitol is obtained from Japan and is sold by Messrs. Zimmermann & Co. (a British firm) at 5s. 6d. per lb., about one-fifteenth the price of Ichthyol.

I use it in the strengths of twenty per cent and fifty per cent in glycerine painted on the wound with a camel-hair brush once or twice daily.

I cannot too strongly emphasize this method of treatment; it saves septic limbs from amputation and if applied at the time of injury will, I am convinced, prevent gas gangrene; the possibility of the prevention of tetanus is also a subject well worthy of consideration.

The dressing should consist of antiseptic gauze, cotton wool and a bandage—impermeable material such as oiled silk should not be applied to a wound.

In conclusion I may add that extension of sepsis and secondary hæmorrhage do not occur with this method of treatment.

I am, etc.,
C. W. Duggan,
Major R.A.M.C.

Military Hospital,
Lincoln,
December 28, 1916.

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Original Communications.

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F. (January to August,* 1916)].

BY LIEUTENANT-COLONEL C. M. WENYON,
Royal Army Medical Corps.
Member of the Medical Advisory Committee; Director of Research in the Tropics to the Wellcome Bureau of Scientific Research.

AND

CAPTAIN F. W. O'CONNOR,
Royal Army Medical Corps.

(*Continued from page* 34.)

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PART II.

PART II.

The Characters and Diagnosis of the various Intestinal Protozoa of Man in Egypt with a Description of Three New Forms.

This section of the report has to do mainly with the morphology of the human intestinal Protozoa. We have not attempted to give a complete description of these. This has already been done fairly completely in other papers, but we have noted some important new points and attention is called to these in the various sections below. Finally, we have described three new parasites—two flagellates and an amœba—which have not been previously found in the human intestine.

(1) *Characters and Diagnosis of Unencysted Entamœba histolytica.*

As regards the morphology of this amœba we have very little to add to what has already been so often described. We are convinced that its identification, apart from the presence of included red blood corpuscles, presents the greatest difficulties even for the expert and trained observer. It is true that a certain type of amœba with refractile ectoplasm, indistinct nucleus and active movement is most likely *E. histolytica*, but very often the amœba

takes on quite other appearances and becomes practically indistinguishable from certain forms of *E. coli.* They sometimes have perfectly distinct nuclei, they may be very sluggish in their movements, they may show little or no distinction between ectoplasm and endoplasm, and they may vary very greatly in the degree of their vacuolation and refractibility. Furthermore, we have seen amœbæ which are undoubtedly *E. coli* moving with an activity which is comparable only with that of *E. histolytica.* Still, as a rule, an amœba is *E. histolytica* if it is moving with an active streaming motion and throwing out pseudopodia, sometimes after several minutes of perfect quiescence, with that peculiarly explosive suddenness which cannot be appreciated unless seen. No amount of description, as James points out, can give an accurate mental picture of this remarkable amœboid activity. It is probably true that a certain type of nucleus is more commonly found in *E. histolytica* and another type in *E. coli*, and that in one it is more often visible in the living amœba than in the other, but here again it is exceedingly doubtful if such details of structure can be employed as a basis of diagnosis. Size is of no value whatever in the differentiation of unencysted forms of *E. coli* and *E. histolytica.* It is a very easy matter to state that a certain type of nucleus belongs to *E. histolytica* and another type to *E. coli*, and dogmatically to diagnose amœbæ accordingly, but is there sufficient evidence that the nuclei maintain their characters so consistently as to justify one in making dogmatic assertions on this basis and to condemn patients to courses of emetin and other treatment accordingly?

In examining stools one often sees highly refractile, distinctly green amœbæ with or without vacuolation. As a rule no nucleus can be seen in them and there is either no movement at all or very sluggish change of shape. They may be perfectly round and it may be difficult on account of the refractile edge to be sure that the amœbæ are not encysted. In other cases there may be numerous short conical elevations or irregularities over the whole surface which are hardly pseudopodia and which remind one most of the short pseudopodia of *Amœba verrucosa;* while at other times there may be several rather long, lobose, sometimes branched pseudopodia which move very sluggishly. Amœbæ of this type are met with both in undoubtedly pure *E. coli* infections and in the "carrier" stage of *E. histolytica* infections. It is not only quite impossible to recognize whether these are *E. coli* or *E. histolytica*, but it is often exceedingly difficult to tell whether they are amœbæ

at all, especially when they occur in association with the large cells so often seen in the bacillary dysentery exudate. Again, *E. histolytica* in acute cases may be very difficult to identify. It often, of course, has the characteristic structure of distinct ectoplasm and granular or vacuolated endoplasm, but at other times it may be nothing more than a clear hyaline apparently structureless mass, or a mass of such material filled with numerous vacuoles. We can recollect having watched a clear hyaline body for some time, wondering the while whether it was a tissue cell on the way to degeneration or an amœba, when suddenly there burst from its side a large pseudopodium and the amœba commenced that series of active movements which one practically never sees except in the case of *E. histolytica.* This particular case had also amœbæ with included red blood corpuscles. We mention these points in order to show how impossible it is at times to arrive at a diagnosis of the amœbæ themselves and how important it is to take into consideration other features of the cases in which they occur.

Realizing the practical difficulties standing in the way of accurate diagnosis we have fixed a very definite standard for our present series of observations—a standard which one of us has upheld and taught for a considerable time in connexion with this work and one which the ordinary observer, who knows how to recognize amœbæ and cysts, can readily follow. We have called no infection one of *E. histolytica* unless we have found at least some amœbæ with included red blood corpuscles present, or unless we could find definite cysts of *E. histolytica* associated with the amœbæ in the stool. It has happened on many occasions that amœbæ have been found in dysenteric and diarrhœic stools which may or may not have been *E. histolytica*, but unless some of the amœbæ contained red blood corpuscles, or unless encysted forms were present, we have left the diagnosis at "free entamœbæ" alone and have followed the cases for several days after the preliminary examinations. Such cases watched from day to day in most instances show cysts of *E. coli* alone in the stool as the symptoms subside, while in a smaller percentage of cases *E. histolytica* cysts appear. In practically all cases in which amœbæ of doubtful nature occur an observation extending over a few days will clear up the diagnosis as cysts make their appearance. There are, however, very rare exceptions to this rule of the appearance of cysts, as has been noted by James in certain cases in Panama. This observer followed three cases of untreated amœbic dysentery for three weeks and no tendency to cyst formation occurred. One of our cases,

however, has been watched for over three months, the stool being examined practically every day, and though the case is undoubtedly one of amœbic dysentery as active amœbæ containing red blood corpuscles have been present from time to time during typical attacks of dysentery, on no occasion have cysts of *E. histolytica* appeared. This case has been treated with emetin on several occasions but has always relapsed sooner or later with a return of the dysenteric symptoms. As a rule, however, cysts occur at some time in the course of infections. For instance, in the case of Russell, H., who was admitted with amœbic dysentery, there was blood and mucus in the stool with active amœbæ containing red blood corpuscles. The case was given a twelve-day course of emetin (one and a half grains a day by the mouth and injection) and the symptoms and infection cleared up. A week later cysts of *E. histolytica* appeared in the stool, and later still the patient was readmitted to hospital with amœbic dysentery. Of course in this case the diagnosis was made on the occurrence of red blood corpuscles in the amœbæ, and the correctness of this was proved by the subsequent relapse with the passage of *E. histolytica* cysts.

The greatest difficulty is likely to occur when persons infected with *E. coli* or carriers of *E. histolytica* suffer from bacillary or other forms of dysentery. The encysted amœbæ are not generally present unless the case is seen very early and it may at times be impossible to diagnose accurately the amœbæ, though the absence of included red blood corpuscles is a very strong argument in favour of their being *E. coli*, for infections with this amœbæ are so much commoner than in healthy or apparently healthy men. The question is, are all such cases to be treated as if they were amœbic dysentery? If so, we are neglecting the possible bacillary element, so that logically such cases would have to be treated as mixed infections and given both emetin and serum or other bacillary dysentery treatment. One may have to adopt this course in certain cases but a guide to treatment can be obtained in other directions. In the first place, the case may be clinically bacillary rather than amœbic dysentery, and though amœbæ are present, i.e., amœbæ without included red blood corpuscles and unassociated with cysts of *E. histolytica*, it should be treated as bacillary dysentery, for as the symptoms subside cysts of the amœbæ will almost certainly appear and the species be identified. Again, much can be gathered from the character of the stool, and it cannot be too strongly emphasized that it is the duty of every medical officer who has charge of dysentery cases to make arrangements whereby he can

see the entire stool of his cases. It is not sufficient either for him or for the person entrusted with the microscopical examination to rely on the patient's statement or to be content with the examination of only a small sample. In many cases this may be sufficient, but, as will be explained below, the picture of the entire stool is so characteristic that a diagnosis can often be made at a glance. Again, the microscopic appearance of the stool apart from the amœbæ is of considerable help. In the examination of a dysenteric stool it is important to examine both the fæcal and mucus parts if both are present, for amœbæ alone may occur in the latter and cysts with or without amœbæ in the former, though this condition of affairs exists only when a carrier case is relapsing into one of acute amœbic dysentery. Case Ball is of interest in this connexion; he was on the staff of the hospital and reported sick with the passage of blood and mucus. The first stool examined consisted of two parts, a fæcal part and a patch of dark blood-stained mucus. The former contained cysts of *E. histolytica* and free amœbæ of the minuta type in large numbers, while the mucus contained many large active amœbæ, some of which had ingested red blood corpuscles. The patient was evidently a carrier of *E. histolytica* relapsing into an attack of acute dysentery. It must also be remembered that any *E. histolytica* carrier case may suffer from bacillary dysentery though it is very doubtful if in such cases the amœbæ which would be of the minuta form would contain red blood corpuscles. Cysts would only be found at the beginning of such an attack when some fæcal matter was still present and probably the flushing action of the dysenteric process would get rid of the free amœbæ as well.

Case Morgan affords an illustration of a case of this type. After only fourteen days in Egypt the patient was taken acutely ill with dysenteric symptoms. There was some fever and the clinical picture was that of bacillary dysentery. Examination of the stool showed the characteristic macroscopic appearance of the disease while microscopically the abundance of pus, mononuclear and macrophage cells, intermingled with red blood corpuscles, further supported this view. In addition, however, the stool contained free amœbæ, none of which included red blood corpuscles, and a fair number of cysts of *E. histolytica*. The amœbic infection had probably been contracted in England, where the patient had served for seven months as orderly in a dysentery hospital. The point of interest is the cause of the attack of dysentery. Unfortunately no dysentery bacilli were isolated from the stool, but the clinical and

other features of the case leave little room for doubt that it was actually one of this disease which was the prevailing type of dysentery at that time. The microscopic appearance of the stool corresponded with this view and the fact that the amœbæ themselves did not contain red blood corpuscles and the presence of cysts indicated that the amœbic infection was not of acute amœbic dysentery type. We therefore feel justified in describing the case as one of bacillary dysentery in a man who was acting as a carrier of *E. histolytica*.

Another case of this type deserves mention. The patient (Gundry) was admitted for dysentery and the microscopic examination of the stool showed the characteristic exudate of bacillary dysentery. The case was reported as probably one of bacillary dysentery in spite of the fact that fairly active amœbæ, none of which contained red blood corpuscles, were present. The case was treated accordingly and the diagnosis was later confirmed bacteriologically by the isolation of a bacillus of the Flexner type. Five days later the patient was passing brown unformed motions free from mucus and some cysts of *E. coli* were found. Free amœbæ had been present every day before this. The following day there were present both cysts of *E. coli* and cysts of *E. histolytica*, and as the patient improved in health these became more numerous, while a large trichomonas infection also appeared. It seems quite clear that this was a case of bacillary dysentery in a man who was a carrier of *E. histolytica*, *E. coli* and trichomonas. The fact that the amœbic infection, which was evidently playing no part in the acute symptoms, was left untreated, did not affect the recovery of the patient from his attack of bacillary dysentery. The *E. histolytica* infection was treated later.

As a result of observations on a long series of cases we would lay down the following rules as a guide to the diagnosis of amœbæ in the stool.

(*a*) If amœbæ containing red blood corpuscles are present in a stool, whether evidently dysenteric or not, they are *E. histolytica*, and mean that some active dysenteric process is going on.

(*b*) If the actual amœbic dysenteric process is so acute as to demand emetin treatment, then amœbæ with included red cells will almost certainly be present in the stool.

(*c*) If amœbæ, none of which contain red blood corpuscles, are present in a dysenteric stool, then the case is either (*a*) bacillary dysentery (or other form of dysentery) with an infection of *E. coli*, or (*b*) bacillary dysentery (or other form of dysentery) occurring

in a carrier case of *E. histolytica* in which there is no active amœbic dysenteric process in progress.

(*d*) In either case mentioned under (*c*) no anti-amœbic treatment is urgent, so that the case can be watched for a few days, during which encysted forms of either *E. coli* or *E. histolytica* will almost certainly appear as the acute symptoms subside, and the diagnosis will be established.

(*e*) Amœbæ, none of which contain red blood corpuscles, and which occur in non-dysenteric stools, may be either *E. coli* or *E. histolytica*. In such cases cysts are nearly always associated with the amœbæ, but if not, treatment for the amœbic infection being never urgent, or not required at all, a diagnosis can be made by examining for a few days till cysts appear, as they invariably do. It sometimes, though rarely, happens that amœbæ cannot be found in the stool, even after several examinations, when actual amœbic ulceration of the large intestine is present. Amœbic abscess of the liver is not infrequent when no amœbæ can be found in the stool. We have discussed the possibility of bacillary dysentery attacking a person who is infected with *E. coli* or is a carrier of *E. histolytica*; but there is another class of case which needs consideration, though we have not come across an example. These are cases in which the *E. histolytica* is actively concerned in the dysenteric process while a true bacillary dysentery exists also. These would be quite different from cases of bacillary dysentery occurring in carriers in which the *E. histolytica* are not actively concerned. If the case is a carrier of *E. histolytica* and develops bacillary dysentery, the disease which demands urgent treatment is the bacillary infection, but if the case is one of true amœbic dysentery combined with true bacillary dysentery it is probable that both diseases should be treated at once. The diagnosis of such cases can only be made by recognizing the clinical and microscopical appearances of bacillary dysentery, isolating one or more of the dysentery bacilli, and at the same time recognizing in the stool the actively motile amœbæ with their included red blood corpuscles. Such doubly acute cases are naturally of rare occurrence, but they must not be confused with cases of bacillary dysentery in which free forms of *E. coli* or "minuta" forms of *E. histolytica* are present in the stool.

(2) *Character and Diagnosis of Cysts of E. histolytica.*

The characters of the cysts of *E. histolytica* with the one, two, or four nuclei, the vacuoles and chromidial bodies are now too well known to need further description from us. We would point out,

however, how closely the cysts may at times be simulated by the I.-cysts, especially, as sometimes happens, as these are devoid of I.-bodies. In such cases the nucleus may be larger than usual, and it may be exceedingly difficult to decide whether one is dealing with *E. histolytica* cysts or not. This difficulty may be still greater in films containing I.-cysts stained by the iron hæmatoxylin method. There the iodophilic body appears not as the refractile structure seen in the unfixed material, but as a vacuolic area by the side of which is the nucleus giving the appearance of a vacuolated *E. histolytica* cyst with a single nucleus (Plate III, figs. 12-17). In these cases the nucleus is generally smaller than the nucleus of the unenucleated *E. histolytica* cyst, and, moreover, is structurally different. The difficulty of diagnosis may be only overcome in some instances by following a case for several days with the careful examination of fresh iodine preparations as a control of the fixed and stained films.

A feature of the *E. histolytica* infection, which the examination of a large series of cases has impressed upon us, is the variation in the size of the cysts. Small forms of *E. histolytica* cysts have been described by James, in Panama, and more recently by Penfold and Woodcock. Kuenen and Swellengrebel described the *E. histolytica* cysts as varying in size between eleven and nineteen microns.

We have noticed a similar variation in size, but it appears that various strains of *E. histolytica* occur. There is one which produces very small cysts associated with correspondingly small "minuta" forms of amœbæ. The cysts are seven to ten microns in diameter and have the same characters as the larger cysts. These are the forms described by James and by Penfold and Woodcock. The small cysts do not appear to be accidentally small, but cases infected with the small strain pass small cysts regularly, at any rate for some weeks, with no tendency for the small cysts to be replaced by the larger ones. For instance, case Kettlewell was observed for three weeks, during which a twelve-day course of one grain emetin injection was given without result, and small *E. histolytica* cysts were found constantly. He was finally cured by a course of emetin by the mouth.

Starting from the strain with small cysts, a series of strains occur with gradually increasing average size of cyst. There are strains in which the cysts measure from 9 to 12 microns, others 10 to 14, others 12 to 16, and finally large strains with cysts measuring 14 to 18 microns. As is to be expected, each strain is associated with "minuta" forms of amœbæ of corresponding size.

It seems very improbable that these strains represent different species of amœbæ, for we cannot be sure that a strain of amœbæ which will produce cysts of small size at one time will never at another time produce larger ones. We have noted, however, that in case Healy, in which cysts of large average size were found for a long time, towards the end of the period of observation a certain number of smaller ones began to appear. The point, however, can only be definitely decided by following individual untreated cases for long periods. In order to illustrate this variation we reproduce below a series of measurements in microns made from cysts as they appeared in iodine preparations. Only cysts circular in outline were measured and the cysts were consecutive ones, as they were observed in working through the preparation with the $\frac{1}{12}$-inch objective.

Case Russell, F. (Plate I, figs. 7-9).—8, 7, 8, M, 7, 8, 9, 8, 7, 8, 6, 7, 8, 7, 8, 7, 8, 7, 8, 6, 9, 8, 7, 8, 7, 8, 8, 8, 6, 8, 8, 9, 8, 8, 8, 8, 7, 8, 8, 8, 8, 7, 8, 8, 7, 8, 8, 7, 9.

Case Kettlewell.—10, 9, 8, 10, 8, 9, 8, 7, 10, 9, 9, 9, 10, 9, 10, 10, 10, 9, 8, 10, 9, 11, 8, 9, 8, 10, 9, 8, 8, 9, 10, 8, 9, 9, 12, 10, 9, 10, 10, 11, 10, 8, 8, 9, 10, 8, 11, 10, 9, 9.

Case Cooper.—10, 12, 12, 11, 12, 12, 12, 13, 11, 13, 12, 10, 12, 13, 10, 12, 13, 11, 12, 14, 12, 12, 9, 13, 12, 12, 12, 11, 11, 12, 12, 11, 12, 13, 12, 13, 11, 11, 12, 10, 12, 10, 12, 12, 13, 12, 11, 11, 13, 12.

Case Noon.—14, 14, 14, 14, 13, 12, 13, 14, 13, 12, 12, 13, 12, 13, 11, 14, 13, 14, 15, 12, 12, 15, 14, 14, 12, 12, 12, 12, 12, 12, 12, 13, 13, 15, 12, 10, 14, 12, 12, 14.

Case Flynn (Plate I, figs. 4-6).—14, 12, 12, 12, 13, 12, 12, 12, 14, 14, 13, 14, 14, 12, 12, 11, 13, 14, 14, 12, 14, 14, 12, 11, 13, 12, 13, 14, 12, 14, 13, 12, 15, 14, 10, 12, 14, 12, 14, 12, 14, 12, 14, 14, 15, 13, 11, 12, 14, 13.

Case Healy (Plate I, figs. 1-3).—16, 18, 14, 14, 12, 14, 15, 18, 14, 16, 16, 14, 18, 18, 18, 14, 16, 16, 16, 15, 16, 15, 14, 15, 14, 16, 14, 16, 18, 18, 16, 15, 16, 12, 14, 14, 15, 12, 12, 13, 17, 14, 14, 16, 16, 14, 12, 15, 16, 14.

The figures (Plate I, figs. 1-9) represent cysts with one, two, and four nuclei drawn to the same scale from three of the above cases. They show graphically the great difference in size of these various strains. It may, however, be safely stated that the majority of cases of *E. histolytica* infection show cysts with a diameter of ten to fourteen microns, but one must always be careful to recognize the smaller and larger strains, for they have to be carefully distinguished from cysts of *E. nana* on the one hand and cysts of *E. coli* on the other.

The cysts of the large strains differ from the cysts of *E. coli* in the more frequent possession of chromidial bodies and the constant presence of not more than four nuclei.

As regards the virulence of the different strains and their reactions to emetin we can make no very precise statements. Case Kettlewell, who had the small strain, did not clear up on injections of one grain of emetin for twelve days, but did on subsequent treatment by the mouth, and case Healy, who had the largest strain, was the most resistant case we had had, and withstood not only emetin injections, but also emetin and pulv. ipecac. by the mouth.

(3) *Are the four Nuclear Cysts of histolytica type necessarily an Indication of Infection with the Pathogenic Amœba?*

All the cases of *E. histolytica* infections have been diagnosed either by the cysts or the presence of amœbæ with included red blood corpuscles; no amœbæ even in dysenteric stools which were not associated with cysts of *E. histolytica*, or with amœbæ showing definite included red blood corpuscles, were entered as *E. histolytica*. The percentage of carrier cases amongst the supposed healthy men, as we have already pointed out, is fairly high and would be actually still higher if allowance were made for the error entering into the single examination system. This being the case, one naturally wonders why, with so many carriers about, is actual amœbic dysentery such an uncommon disease in Egypt at the present time; and secondly, are the tests one applies for the detection of carriers reliable, and are the cysts of *E. histolytica* as one recognizes them in reality the cysts of the pathogenic amœba which produces amœbic dysentery? Doubts on this score have arisen in the minds of some, naturally enough when one realizes the great discrepancy between the number of carriers and acute cases. That the so-called cysts of *E. histolytica* are what they are supposed to be can hardly be doubted by anyone who has followed the literature dealing with the subject during the last few years. Cases of amœbic dysentery have been followed by several observers through convalescence and as the dysenteric symptoms abate the characteristic cysts begin to appear in the stools. Other cases which have been in the "carrier" condition passing cysts in the stools have relapsed into attacks of acute amœbic dysentery. Cysts from carrier cases have been administered to cats and these have contracted acute amœbic dysentery and even amœbic abscess of the liver. Further, Darling has shown that cats infected in this way if they tend to recover from the attack of amœbic dysentery

commence passing *E. histolytica* cysts in the stool. The evidence seems to be as complete as it possibly can be, short of some method of maintaining *E. histolytica* in pure artificial culture. Some further evidence in this direction has been the outcome of our observations on cases of amœbic dysentery and carriers in Egypt. Two cases—Blair and Russell, H.—were admitted to hospital with amœbic dysentery, there being blood and mucus stools containing active amœbæ with included red blood corpuscles but no cysts. The cases were treated with emetin and the dysenteric symptoms and the amœbæ disappeared. Both these cases relapsed later. Case Russell, H., began to show cysts of *E. histolytica* with small amœbæ and a fortnight later had another attack of amœbic dysentery. Case Blair recovered in the same way under emetin treatment, but amœbæ and cysts of *E. histolytica* were present a fortnight after treatment was stopped. Both these cases had had repeated attacks of dysentery before coming under the present observation.

If an individual who is a carrier of *E. histolytica*, and is passing encysted forms in the stool, relapses into acute dysentery one should be able to observe the transition if the case is examined early enough. A case of this kind was seen under very favourable conditions for this examination. A patient (case Ball) was one of the hospital staff who had had repeated attacks of dysentery and much emetin treatment. He was suddenly taken ill with dysentery and the stool was examined almost at once. It consisted of two parts, a fæcal portion and a blood and mucus portion. The former contained numerous cysts of *E. histolytica* with some amœbæ, and the latter numerous active amœbæ with included red blood corpuscles. It was evident that this was an instance of a carrier relapsing into a condition of acute amœbic dysentery. He was treated with emetin and the symptoms and infection vanished, but ten days later cysts of *E. histolytica* were again present. Another course of emetin was given and the infection again disappeared, only to return with cysts and amœbæ three weeks later. In two other cases (Rushforth and Dorter) a similar condition of affairs existed at the first examination, there being acute dysentery with active amœbæ containing red blood corpuscles and associated with cysts of *E. histolytica*. Both these cases relapsed after emetin, and cysts of *E. histolytica* appeared in the stools. In the case of Dorter there was a previous history of much dysentery, whereas with Rushforth there had been no previous dysentery, the patient having only been in the country a short time.

In the majority of cases of actual amœbic dysentery cysts of *E. histolytica* cannot be discovered, though an examination of a fæcal portion of the stool, if such be present, may reveal them when only free amœbæ are to be found in the blood and mucus part. Cases like those recorded above leave little room for doubt that the cysts of *E. histolytica* are definitely related to and derived from the amœbæ which give rise to the dysenteric symptoms. One case, however, must be mentioned, for in it no cysts of *E. histolytica* could be found at any time, though there were repeated attacks of dysentery which were cured temporarily by emetin treatment. This case, Smith, was followed most carefully from April 5 to July 15, specimens being examined on eighty-eight days. The case was admitted for dysentery, the stool containing blood and mucus and active amœbæ with included red blood corpuscles.

Emetin treatment caused the amœbæ and symptoms to disappear but relapse occurred, and at this time there were no cysts but only the amœbæ as on the previous occasion. Another course of emetin was followed by a similar relapse, while a further course of methyl emetin sulphate had no effect on the infection. As already remarked, on no occasion were cysts of *E. histolytica* found, though it must be noted that cysts of *E. coli* were present in small numbers on one or two occasions during the first month of observation—a fact which might appeal to those who wish to claim a pathogenicity for *Entamœba coli*. Why then did not the *E. histolytica* in this case produce any cysts? The only explanation seems to be that the case was in a constant state of acute dysentery. The stool was practically always either liquid or unformed, without any administration of salines, and there was nearly always mucus and often blood mixed with the fæcal matter or separate from it. It is interesting to note that a tetramitus infection which was also present on no occasion produced any cysts, and it may be that the unknown factor which prevented the encystment of the *E. histolytica* prevented also the encystment of the tetramitus. In this particular case however the diagnosis was never in doubt, as amœbæ with included red blood corpuscles were frequently found.

It has already been mentioned that several observers have produced dysentery in cats by giving them cysts of *E. histolytica* by the mouth. We have recently repeated this observation with material from case Carr. There was a very large infection of *E. histolytica* cysts—in fact the largest infection we have come across. There was no history of dysentery whatever, so that the case can be looked upon as a healthy carrier. A small quantity of

the stool of this case emulsified in saline was poured into the mouth of a kitten, which was then caged with another of the same age. Both kittens became ill with dysentery and died in a week. In both cases there were numerous amœbæ in the large intestine and both showed extensive ulceration. The experiment is valuable in showing that the cysts of *E. histolytica* in a perfectly healthy carrier, who had no history of dysentery, and who was only discovered to be a carrier in the routine examination of healthy men in camp, were capable of giving rise to a fatal dysentery in animals. Furthermore it is evident that the second kitten contracted infection from the first, probably just after feeding by licking material which was adhering to the fur about the mouth of the first. An experiment of this nature suggests very strongly that the cysts from such a carrier case might give rise to acute dysentery in another individual and that the same individual himself might pass into a condition of acute dysentery at a later date. A reference to the protocols will show that case Carr was cured by a course of emetin.

The arguments in favour of the cysts of *E. histolytica* being actually the cysts of the pathogenic entamœba are therefore these :—

(1) Cases which are passing cysts of *E. histolytica* may relapse into acute dysentery when amœbæ with included red blood corpuscles appear in the stool.

(2) Cases of acute amœbic dysentery showing amœbæ with included red blood corpuscles may recover naturally and in the process the large active amœbæ become replaced by smaller forms and cysts of *E. histolytica*.

(3) Cases of acute amœbic dysentery of the above type may be cured with emetin, but often such cases relapse when cysts of *E. histolytica* appear in the stool.

(4) Cysts from perfectly healthy carrier cases who have no previous history of dysentery will give rise to fatal amœbic dysentery in kittens.

Taking all these points into consideration, there can be no doubt that the detection of the characteristic cysts of *E. histolytica* in the stool is in reality an indication that infection with the pathogenic amœba exists.

(4) *The History of Carriers of E. histolytica.*

Having decided that the cysts of *E. histolytica* are actually the cysts of the pathogenic amœba, it becomes of the utmost importance to know what happens to such carrier cases, how many of them

actually suffer from dysentery at some time or other, how many of them recover spontaneously, how long they may remain carriers and what is the condition of the large intestine while they carry their infections.

(*a*) *How long do Carriers remain infected ?*—This is a question which only very prolonged observations can answer. In certain cases, however, long histories of repeated attacks of dysentery can be obtained. For instance, case Healy, who proved so resistant to emetin treatment, had suffered off and on for five years and when examined he was just recovering from an acute attack of dysentery, and was again passing into a condition of a carrier with cysts and amœbæ in the stool. Another case, Spiers, gave a similar history of a slightly shorter duration. Another case of this kind was seen by one of us (C. M. W.) in London some years ago, and was one of a postman who had been invalided from the West Indies on account of dysentery. He stated he had had repeated attacks during a period of five years since his return to England. Examination of the stool showed that it was soft and unformed and was dotted over with small flakes and streaks of mucus as is common in these cases. There was a very large infection of cysts of *E. histolytica* and small amœbæ.

These cases show clearly that individuals may remain as unhealthy carriers over long periods and as far as we can judge it may be for the rest of life.

The length of time that a person may remain a healthy carrier is much more difficult to decide, for there is no history of repeated dysentery to guide us. One case of known infection has been under observation for six months, and though cysts of *E. histolytica* have been present constantly there has been no dysentery during this period, nor was there a previous history of dysentery or diarrhœa. This case (Cox) was given a course of emetin injections, which only caused the cysts to disappear from his stool for a short time.

That infections of this kind can exist for long periods without any symptoms is borne out by the fact that such a large percentage of the "carriers" we have found during the routine examination of healthy men have given no history of dysentery whatever. For instance, of 106 carriers discovered amongst 1,979 healthy men only 16 gave any history of dysentery, and it is certain that the latter figure is too high, for in no case can we be certain of the type of dysentery from which the case suffered.

In a certain number of instances men who have been found to be carriers have been brought into hospital for treatment, and while

under control before treatment was commenced it was noticed that the infection began to decline and finally disappeared. Three such cases were examined regularly for fifteen, eighteen and twenty-six days respectively after the spontaneous disappearance of the *E. histolytica* cysts from the stool without there being any recurrence. It was impossible to retain these men any longer, but whether the observation indicates a spontaneous recovery or not it shows that an infection may disappear for a considerable period. In none of these cases was the infection a large one. On the other hand, in the great majority of our cases which were controlled for a week or ten days before treatment was commenced there was no tendency for the infection to disappear as in such cases as that of Healy who was controlled for nearly three months and was rarely free from cysts of *E. histolytica*.

(*b*) *What Percentage of Carriers pass on to an Acute Dysenteric Condition ?*—This question is even more difficult than the preceding one, for an answer can only be obtained by controlling cases for long periods and this has not yet been done to any extent. It is clear that many cases can carry their infections for at any rate many months without symptoms and it is equally clear that others may have repeated attacks of dysentery in a similar period. Between these two extremes there are many intermediate types where infected individuals have mild attacks of diarrhœa with or without mucus in the stool, which may or may not be the result of the *E. histolytica* infection. A certain number of carriers complain of pain over the large intestine or of other symptoms which are difficult to explain except on the assumption that some intestinal ulcers exist. Others say that they never pass a really formed stool. It is perfectly clear however that a large percentage of men who are stationed even for a short time in Egypt become infected with *E. histolytica*. A certain though yet unknown, but by no means negligible, percentage of these pass on to a condition of amœbic dysentery and have to be invalided from the Service. It is evident, therefore, that in the transference of new troops from England to non-infected centres, it is inadvisable to station them in the first place in endemic centres of amœbic dysentery like Egypt unless important military requirements leave no other alternative.

(*c*) *What is the Condition of the Large Intestine in the Carrier ?*—It has been suggested that *E. histolytica* can live in the large intestine as *E. coli* does without producing any lesion of the gut, and that this is the condition of affairs in the carrier cases as distinguished from the amœbic dysenterics who have definite

ulcerations. It seems, however, very doubtful if this is actually the case, for many facts seem to indicate that some ulceration of the intestine exists in these cases, though it produces no symptoms.

It is a well-known fact that at *post-mortem* examinations in countries where amœbic dysentery is endemic, amœbic ulceration of the large intestine is often encountered in cases in which there is absolutely no history of previous dysentery. In 1910 Musgrave published an account of fifty such cases in the Philippines. Others have had a similar experience elsewhere, and quite recently the Thompsons (JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, June, 1916) state that Bartlett had noted amœbic ulceration in the intestine of soldiers from Gallipoli who had died of wounds or other cause when amœbic dysentery was not suspected.

It is a remarkable fact that ulceration of the large intestine, sometimes quite extensive, can exist without giving rise to symptoms. It is probable that in these cases where amœbic ulceration was found after death, though quite unsuspected during life, an examination of the stool would have revealed the condition of the carrier case with cysts and free amœbæ in the stool.

In cases, such as those of Healy and Spiers mentioned above, where there is a long history of repeated attacks of dysentery extending over several years, and where during the intervals between the attacks the stools are never normal, always being soft and mixed with a certain amount of mucus, it is impossible to doubt that there exists an extensive ulceration of the intestine. In fact, thickening of the large intestine and painful areas can be found on palpation. These cases during the interval between attacks of dysentery show only cysts of *E. histolytica* and small amœbæ generally in very large numbers. In other cases between the dysenteric attacks the stool may approach the normal and mucus be not apparent, though the number of cysts and amœbæ passed may be very great. Furthermore, there are many carriers who give a history of one attack of dysentery. In them there must have been ulceration at this time, and it seems probable that such ulceration must persist when acute symptoms are in abeyance. Finally, there are the carriers who give no history of dysentery whatever. In many of these a careful examination of the stool will often reveal small flakes and streaks of mucus, and though its presence is not necessarily an indication of acute ulceration, it is proof that some abnormal condition of the intestine exists, for it must be remembered that in the worst and most persistent cases with undoubted ulceration present the condition

of the stool between the actual attacks of dysentery may only be abnormal in that it is usually soft and unformed with a certain amount of mucus present. In fact, the stool in these intervals may be both macro- and microscopically exactly like the stool of a carrier who gives no history of dysentery whatever.

It is to be noted that a small percentage of these healthy carriers complain of pain over the large intestine.

The development of liver abscess in cases which give no history of dysentery is far from uncommon, and it seems justifiable to assume that these cases must have been carriers of *E. histolytica* and must have suffered from unrecognized ulceration of the large intestine.

Taking all these points into consideration it seems safe to assume that the *E. histolytica* in the intestine of the carrier case is not comparable with the perfectly harmless *E. coli*, but that it is the cause of a certain amount of ulceration, and we know that this ulceration may be quite extensive without giving rise to any definite dysenteric symptoms.

Another argument in favour of this view is the remarkable action of emetin on the *E. histolytica* infections and its comparative inaction on those of *E. coli*. It seems difficult to understand why the drug should be more toxic to one than another amœba if they were both living under similar conditions in the large intestine. Yet administered by injection to a healthy carrier showing infections of both *E. histolytica* and *E. coli*, it is the former which disappears, while the latter, as a rule, persists. It seems most probable that the drug given in this way reaches the *E. histolytica* more easily than the *E. coli*, and the only way in which this could occur would be if the *E. histolytica* had a different habitat from the *E. coli*. This difference can be readily explained if we assume that, in the carrier, the *E. histolytica* is living in or about intestinal ulcers while the *E. coli* is more uniformly distributed over the healthy gut. The injected drug would thus reach the *E. histolytica* through the circulation, while the *E. coli* would escape. This view is supported by the fact that emetin administered by the mouth generally causes temporary disappearance of both *E. histolytica* and *E. coli*. Though we assume that infection with *E. histolytica* means ulceration of the large intestine it still remains a fact that the type of ulceration in a carrier case must be different from that in an acute dysenteric. The ulcer in the carrier is probably of a more indolent nature without there being active destruction of tissue or outpouring of exudate from its surface. Living in the

deeper tissues of the ulcer are large amœbæ, while towards the surface of the ulcer, and possibly to a large extent over the surface of the gut around the ulcer, are smaller amœbæ which have been produced by successive divisions of the larger forms. Here on the surface these small amœbæ, the minuta forms, become encysted and produce the typical cysts of *E. histolytica*, which escape in the stool. If for some reason such an indolent ulcer becomes acute there is a greater activity and multiplication on the part of the deep-seated large amœbæ and a greater outpouring of exudate with blood and mucus. In this process the small amœbæ and cysts on the surface of the ulcer are washed away and will only be found in the stool at the commencement of the dysenteric attack, while the now active large amœbæ escape from the ulcer in the exudate, and appear in the blood and mucus stool where they are seen actively crawling about with included red blood corpuscles. When the dysentery abates the ulcer returns to its more indolent state, while the small amœbæ are again produced and the cysts reappear. An acute attack of dysentery may arise, however, not from an increase in the activity of an existing indolent ulcer, but by a fresh attack on some still healthy part where a new ulceration is being established.

The above conception, admittedly somewhat theoretical, fits in well with what we know of the history of many of the carrier cases of *E. histolytica*, and affords a possible explanation of the difference in the action of emetin in *E. histolytica* and *E. coli*.

(*d*) *How does E. histolytica establish itself in the Human Intestine?*—Individuals become infected with *E. histolytica* by ingesting the well-known four nuclear cysts. This has been experimentally proved in cats by many observers, and by Walker and Sellards (1912-1913) in the case of human beings. As there occur so many carriers who have never suffered from dysentery it is clear that many become infected with *E. histolytica* without showing any signs of their infection, at any rate, for some time. In their experimental infection of human beings Walker and Sellards found that only a small percentage (four out of eighteen) of those who became infected actually developed definite dysenteric symptoms. It would seem probable that in nature too the majority of those who become infected acquire at first a benign infection which can only be recognized by an examination of the stool, and that it is only later that the ulcerative process becomes acute or extensive enough to give rise to dysenteric symptoms. In other words, the cases become first of all healthy carriers and then only later lapse into a condition of amœbic dysentery. It is but rarely that one has an oppor-

tunity of obtaining evidence to support this view. Case Rushforth, already referred to above, was seen at the commencement of his first attack of dysentery, and in his case cysts of *E. histolytica* were found as well as active amœbæ with included red blood corpuscles. It would seem that the case had been a carrier of *E. histolytica* without showing any symptoms, and was just then lapsing into a condition of acute amœbic dysentery. Though this is probably the commonest mode of onset of amœbic dysentery, in a certain number of cases actual dysentery sets in soon after infection has taken place without there having been a previous "carrier" period. This was the experience of Walker and Sellards in their infection experiments, where a small percentage of the men who became infected had attacks of amœbic dysentery within a comparatively short time (ten days or more) of ingesting the infective material. In cats, again, it is usual for actual dysentery to occur without any intervening "carrier" period; in fact, no one, as far as we are aware, has yet produced a "carrier" condition in a cat without there having been actual dysentery first. These primarily acute cases, as with the cases of dysentery which are lapses from a "carrier" condition, naturally clear up clinically without treatment, and pass into the carrier condition, which must be looked upon as the most usual normal type of infection with *E. histolytica*.

The idea that a parasite should give rise in most cases to very few or no symptoms at all in its host is not strange in any way and is merely an indication of an adaptation of host and parasite to each other, a condition of affairs which is, so to speak, the ideal arrangement aimed at by a parasite. Any parasite which quickly destroys its host is very soon likely to be destroyed itself.

E. histolytica infections may therefore be established in the following ways after ingestion of the infective cysts:—

(1) The case may become a carrier case showing amœbæ and cysts in the stool without there having been any evidence of previous dysentery and without any tendency to the development of acute symptoms.

(2) The case may have a primary attack of amœbic dysentery and pass on into the carrier condition later.

(3) The case may become a carrier and then lapse into a condition of amœbic dysentery only to become a carrier again as the symptoms subside.

As already mentioned above it is possible that the great majority of carriers eventually show dysenteric symptoms, but as yet we have a very few data to go upon. Actual amœbic dysentery is

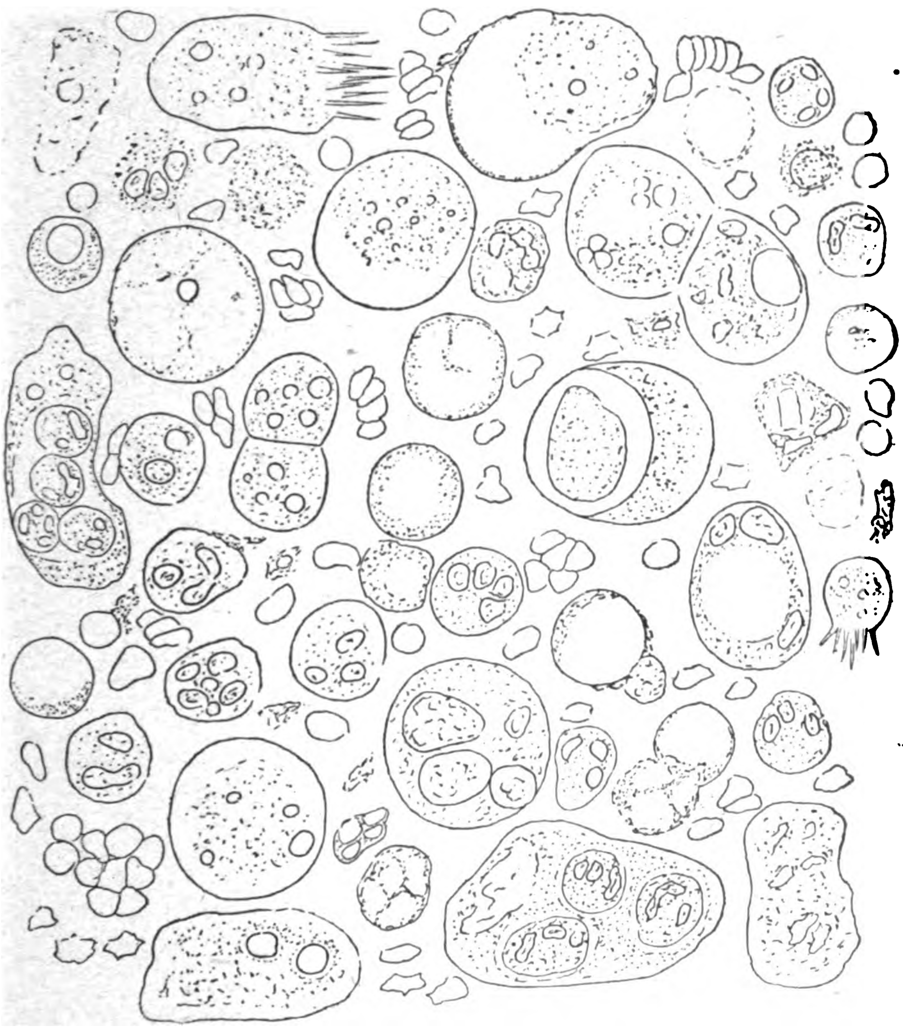
essentially a chronic disease and persons who suffer from it are constantly having attacks of dysentery alternating with periods of freedom from the acute symptoms. During the attacks amœbæ with included red blood cells can be found in the stool while between the attacks there occur cysts of *E. histolytica* and small minuta amœbæ. During the attacks the stools contain blood and mucus, while between the attacks the stools may approach the normal or, what is more usual, they remain soft and mucoid, being of a peculiar sticky character, due to admixture with mucus in the form of small flakes or streaks.

(5) *Character and Diagnosis of the Dysenteric Stool.*

It has already been stated that much information as to the type of dysentery present can be gathered from the features of the stool. The typical bacillary dysentery stool is so characteristic that with very little experience one can recognize the condition at a glance. The amœbic dysentery stool is also fairly typical but not so much so as that of bacillary dysentery.

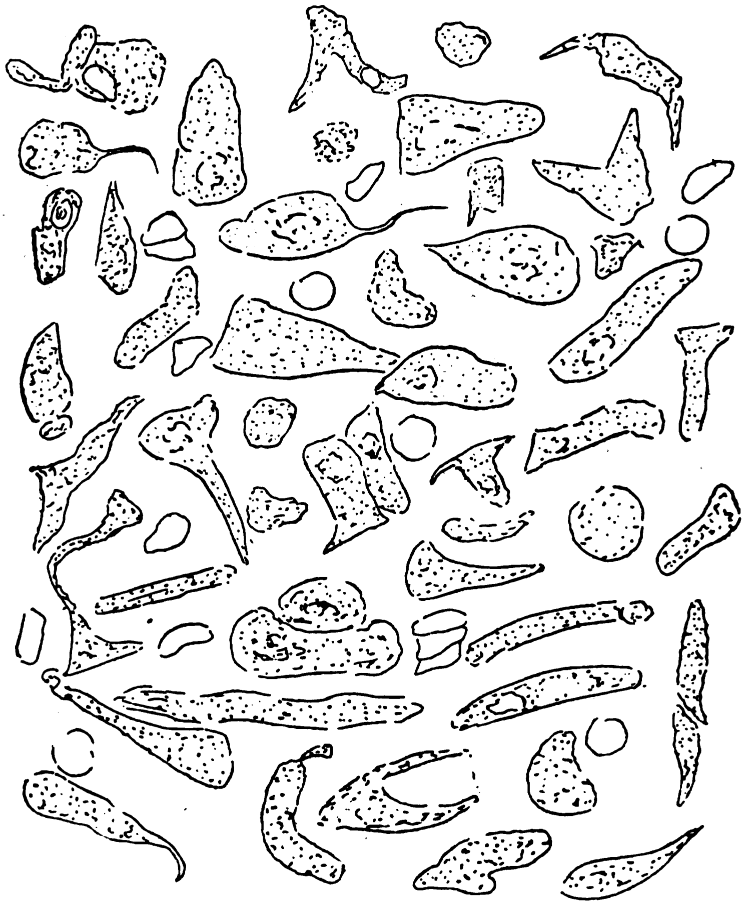
(*a*) *The Character of the Stool in Bacillary Dysentery.*—Bacillary dysentery sets in with acute diarrhœa, which very soon washes all the fæcal matter from the gut, and it is after this that there is found the glairy white or yellowish white mucus streaked or flecked with blood which is very little altered in colour. When seen in the bed-pan this mucus may be sufficiently liquid to pour to and fro or it may be more tenacious and adhere to the bottom of the vessel. It may be the only material present, or there may be a certain amount of fæcal matter between patches of mucus. A small portion of this mucus examined under the microscope shows a varying number of red blood corpuscles on a white field composed almost entirely of pus cells, a smaller number of larger round mononuclear cells and a still smaller number of very large cells which remind one of nothing so much as the large hypertrophied endothelial cells of the blood-vessels. This large type of cell is very commonly found in certain diseases and is generally known as the macrophage. In kala-azar it is the large cell which contains the Leishmania and in malaria it may be found in the peripheral blood. It seems to us that the large cells seen in bacillary dysentery probably have a similar origin. Any of the cells described above may be phagocytic, especially the round mononuclear cells and those of the macrophage type. They frequently ingest the polynuclear pus cells and also red blood corpuscles and it

is this feature which renders their confusion with amœbæ such an easy matter for the uninitiated. The macrophages, however, are non-motile, or practically so, even in the perfectly fresh stool. Another feature of this overwhelming cellular exudate is that the individual cells may appear fairly healthy or they may show excessive necrosis, being reduced to nothing more than vesicles, the limits of which are the remains of the cytoplasm or nuclear membrane. The cells show all kinds of granular degenerative changes, but very frequently one finds greenish homogeneous highly refractile spheres in the cytoplasm of the cells. These spheres are probably of a fatty nature, but their importance, from the present point of view, is that they have been mistaken for nuclei of amœbæ or even red blood corpuscles. It is well to remember that the nucleus of an amœba is never a homogeneous refractile body, but is recognized by the ring of granules at its periphery, while the interior appears of much the same colour as the cytoplasm outside. While the cells which have been mentioned above are the ones most commonly seen in the mucus of bacillary dysentery there occur sometimes patches of mucus showing another type of cell. These are elongated cells changed and distorted in various ways and are evidently derived from the columnar cells of the gut wall itself. This type of cell occurs very commonly in the mucus one so often sees around the formed fæces of the post-dysenteric condition. In these cases the cells seem to have originated from mucous membrane of the lower part of the large intestine. The pus and other cells described above are probably purely exudate cells derived from the outpouring of liquid from lymphatics and blood-vessels, while the latter are exfoliations from the gut wall. The two plates are of outline drawings of cells made from a bacillary dysentery stool and illustrate the cellular exudate on the one hand and the exfoliation type of cell on the other (text figs. 1 and 2). If films of this cellular exudate are stained after wet fixation by iron hæmatoxylin all kinds of strange pictures are developed, which are a result of the active phagocytosis and nuclear degeneration which is taking place. The pus cells with their fragmented nuclei when four portions are present may simulate the cysts of *E. histolytica*. The remains of the nuclei of phagocyted cells in the cytoplasm of larger cells may suggest reproductive phases, such as schizogony of some protozoon, while it may be impossible at times to distinguish between degenerating cells and degenerating amœbæ. With such a collection of curious and unusual objects before one it is necessary to be on one's guard



Text Fig. 1.—A composite plate showing the different cells met with in the mucus of a bacillary dysentery stool. Actually the pus cells are more numerous than represented in the plate. They form at least ninety per cent of all the cells present. The small rings and irregularly shaped bodies with clear interiors are red blood corpuscles.

against errors of interpretation. The characteristic features both macro- and microscopic of the bacillary dysentery stool have been insisted upon by observers before this. Bahr, in his account of



TEXT FIG. 2.—Another appearance met with in the mucus of a bacillary dysentery stool. The cells here are evidently the superficial gut cells in various stages of degeneration. They are not nearly so commonly seen as the cells shown in text fig. 1. Cells of this type are often seen in mucus derived from the gut in conditions other than bacillary dysentery. This drawing was actually made from a single microscopic field.

bacillary dysentery in Fiji, draws attention to the large cells which may be mistaken for amœbæ. Stitt in his "Manual of Tropical Diseases" repeatedly refers to the characters of the bacillary

dysentery stool, the type of cell found in the cellular exudate, and warns his readers against the error of mistaking some of these cells for amœbæ. Quite recently Willmore and Sherman have again recognized the value of the microscopic appearance of the cellular exudate as an aid to the diagnosis of bacillary dysentery. With this view we entirely agree. So convinced are we of this characteristic appearance that the cases we have examined are returned as "probably bacillary dysentery" if it is present, and the cases are treated accordingly. From the point of view of the patient this is most important, for bacteriological examination cannot give an answer quickly enough. Theoretically it may be possible to isolate and diagnose the bacillus in thirty-six to forty-eight hours, or occasionally in eighteen hours, but this is the critical period for the patient and it is during this period that active anti-dysenteric treatment should be adopted. As a matter of fact in practice the bacteriological diagnosis takes longer than forty-eight hours on an average, so that frequently all signs of dysentery have vanished before the report is obtained. It is obvious therefore that bacteriological diagnosis is too slow to be of use in assisting at the early treatment and one must have recourse to other methods—viz., a consideration of the clinical characters of the case, the macroscopic appearance of the stool and the microscopic appearance of the exudate. While the type of stool described above is typical of the bacillary dysenteric attack at one period of its development, it must not be forgotten that before and after this the stools may be very different. Often a patient does not report sick till the blood and mucus appear, and by the time that he is in hospital it may have vanished. The character of the stools after the blood and mucus stage depends largely on the type of diet the patient has had. As a rule he has been too ill to want much food. Often at this stage one sees what we have called the brown liquid stool which differs macroscopically in no way from the stool which would result from a saline purge. Microscopically, however, one may find all the cells present which one finds in the typical bacillary dysentery mucus. They are, however, uniformly distributed through the liquid fæcal matter, though patches of cell agglomerations may occur here and there. This appearance probably indicates a bacillary dysentery which has passed the mucus stage, or a case which will not develop the mucus stage at all. In reporting on these cases, however, much greater caution is needed, for a stool of this kind may be produced by chronic amœbic conditions or by the ulceration of the large intestine which

is left after the amœbic infection has disappeared after treatment. A case illustrating this point is described below. At other times in bacillary dysentery one sees a stool like the rice water stool of cholera, and here again there is an abundance of pus, mononuclear cells and large macrophages. As the dysenteric condition passes off the cellular elements diminish till finally the microscope fails to yield any information.

(*b*) *The Character of the Stool in Amœbic Dysentery.*—When we come to the characters of the stool of amœbic dysentery the difficulties to be encountered are much greater. When actual dysentery is present the blood and mucus are much darker in appearance than the blood and mucus of bacillary dysentery. The blood may be black or brown while the mucus is often transparent and dark brown in colour. The blood and mucus again is more often mixed up with fæcal matter, and one does not have the picture of the bottom of a pan covered with whitish mucus and blood as in bacillary dysentery. Again, in amœbic dysentery the stool may be merely a soft unformed stool, which on close examination is found to be impregnated with mucus intimately mixed with the fæcal matter. Such a stool may be termed mucoid.

Microscopic examination of the stools of the amœbic dysenteric shows nothing characteristic apart from the amœbæ. Cells of many kinds are present, in fact any of the cells described as occurring in bacillary dysentery. But the cells are never present in such numbers and one does not find that condition where the whole field is covered with them. There are then no cells characteristic of amœbic dysentery, but the absence of the bacillary dysentery picture may lead one to assert that the case is probably not bacillary. A diagnosis can only be arrived at by finding the amœbæ with their included red blood cells. If these are not present the case may be one of some other disease, but may still be amœbic dysentery, for in these cases it sometimes happens that the amœbæ cannot be found at the first examination.

Another and very important point which must not be forgotten in these cases is that a negative bacteriological or protozoological examination does not exclude the disease. It is probably true that a microscopic examination of amœbic dysenteric stools will give a positive result in a few minutes more frequently than a bacteriological examination of a bacillary dysentery stool will in as many days; but even the protozoological examination will fail sometimes. To avoid such errors the stools should be examined on several occasions, when the chances of error will be reduced to a minimum.

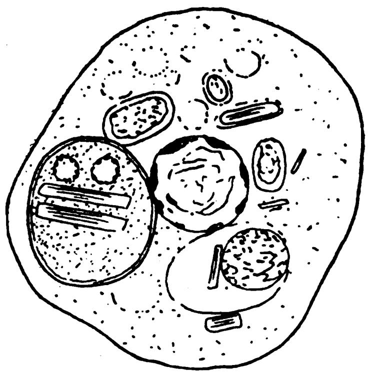
An instructive case in point and which has been referred to above is the following. The patient, who had been invalided from Mesopotamia with dysentery, was admitted to hospital in Alexandria. The stool, which was a brown liquid one, did not contain evident blood and mucus but microscopically there were present numerous blood, pus and other cells reminding one of the picture of a bacillary dysentery in the post-mucus stage with liquid stool. No amœbæ were found. The stool was examined on two other occasions with a similar result. The bacteriological examination was also negative. It was assumed to be a case of bacillary dysentery, and as the diarrhœa continued with the passage of blood and pus cells the case was treated with repeated injections of serum. An irregular temperature developed and the patient eventually died. At the post-mortem the upper part of the large intestine showed extensive amœbic ulceration while the lower half was denuded of mucous membrane, save for a few scattered islets here and there. There was also a large abscess of the right lobe of the liver, which formed a mass adherent to lung and diaphragm. Examination of the liver abscess pus showed numerous active *E. histolytica*, while scrapings from the intestinal ulcers showed no amœbæ at all. This case had previously been treated with emetin, so that it is possible the intestinal infection had vanished while the liver infection had remained. The important point of the case is that the microscopic examination of the stool on three occasions failed to give a diagnosis of the true condition, which in this instance could only have been arrived at by clinical methods. The bacteriological and protozoological examination may give a definite and conclusive answer in most cases, but the clinician must remember that he must help in the diagnosis to some extent however empirical his methods may be.

(6) *Characters and Diagnosis of Unencysted E. coli.*

Our remarks as to the difficulty of identifying the free unencysted forms of *E. histolytica* apply equally to *E. coli.* There is a type of amœba which one sees in non-dysenteric cases which can almost certainly be recognized as *E. coli* without the presence of the eight nuclear cysts. These are amœbæ with a thin rim of pale not highly refractile ectoplasm enclosing an endoplasm which is much vacuolated and which contains bacteria, bacilli, yeasts and other objects, while the rather large nucleus, distinct because of the coarse granules of chromatin on its membrane, can be clearly distinguished. These amœbæ move sluggishly as a rule and throw

out pale non-refractile pseudopodia. *E. coli*, however, frequently departs from this type, and as already mentioned we have seen *E. coli* moving as actively as any *E. histolytica* does. The character of the amœbæ changes also, so that they may resemble certain forms of *E. histolytica* structurally, and it is possible this change in appearance is dependent in some way upon the character of the stool. *E. coli* in dysenteric or a diarrhœic stool never has the same appearance as when it occurs in a normal stool.

In an absolute diagnosis of this amœba we must rely on finding the characteristic cysts, for we have no such criterion as the ingestion of red blood corpuscles to guide us.



TEXT FIG. 3.—*Entamœba coli* with ingested cyst of *E. histolytica* (two-nuclear stage). Case Boyd, May 13, 1916.

Amœbæ however in a dysenteric stool which do not, any of them, contain red blood corpuscles are most probably *E. coli* for the simple reason that *E. coli* infections are so much more common in healthy individuals than *E. histolytica* infections.

If amœbæ show many vacuoles, especially vacuoles which are large elongated almost rectangular fissures, they are probably *E. coli*. The remarks made under *E. histolytica* as to the propriety of waiting for a diagnosis when only unencysted amœbæ can be found apply equally here, for no one in these days would advocate treating all amœbic infections with emetin. When free amœbæ alone are found, the following of a case daily for a few days will almost certainly reveal encysted forms. In one case only, which had a persistent diarrhœa, free amœbæ alone were passed for nearly a fortnight before *E. coli* cysts appeared.

E. coli is much more omnivorous than *E. histolytica* and one more frequently finds bacilli, cocci, yeasts, long coiled up leptothrix and unidentifiable structures within the cytoplasm. On two occasions we have seen a large amœba, almost certainly *E. coli*, which had phagocyted a cyst of *E. histolytica*. A drawing of one of these is reproduced (text fig. 3). Cysts of lamblia are also ingested by *E. coli*. Though bacteria of all kinds are taken up readily by *E. coli*, one sometimes finds bacteria within undoubted *E. histolytica*. On several occasions we have noted short bright refractile rods in *E. histolytica* as well as in *E. coli*. These are spores of a spore-bearing bacillus (probably *B. megatherium*) which is fairly common in fæces in Egypt (text fig. 4). On another occasion most of the amœbæ in an *E. histolytica* infection had ingested larger oval refractile structures which were probably yeasts.

Does E. coli ingest Red Blood Corpuscles? Some observers have declared that *E. coli* may, under certain circumstances, phagocyte red blood corpuscles. They have not, however, told us why the entamœbæ observed could not have been *E. histolytica*. If one decides that a certain type of nucleus or cytoplasm must of necessity belong to *E. coli*, then of course one is bound to declare any amœba, with such a nucleus, whether it contains red blood corpuscles or not, to be *E. coli*. For instance, James, discussing this question, states that in mixed infection of *E. coli* and *E. histolytica* in stools containing blood, he has found red blood corpuscles in varying quantity in the interior of the pathogenic organisms but rarely within coincident *E. coli*, and then only one or two at a time. Is it not possible that in such cases the amœbæ were really *E. histolytica* which had come very near to *E. coli* in structure? In order, therefore, to test the powers of *E. coli* to ingest red blood corpuscles we have made some experiments about which there could be no shadow of doubt. A case of pure *E. coli* infection which had been followed continuously for nearly four months was used. On two occasions when the free amœbæ were present in large numbers a portion of the perfectly fresh stool was mixed with a quantity of finger blood of the infected individual on one occasion and with the blood of another individual on a second. The mixture was placed at once in the warm incubator and examined from time to time. The amœbæ were moving freely amongst the blood cells, and though the red blood corpuscles became adherent to the surface of the amœbæ none of them were

ingested. It is clear, therefore, that *E. coli* does not readily ingest red blood corpuscles under the conditions of the experiment.

Our observations in cases of bacillary dysentery with much blood in the stool, and where *E. coli* were present as demonstrated by the subsequent occurrence of *E. coli* cysts alone a few days later, all go to show that even in the gut where there is an abundance of red blood corpuscles present the amœbæ do not tend to ingest them. On the contrary, all cases with amœbæ showing red blood corpuscles have proved on careful investigation to be cases of *E. histolytica* infection.

On the other hand, the experiment outside the body we have repeated with the small form of *E. histolytica* which occurs in carrier cases. Though the amœbæ were moving actively they did not ingest the red blood corpuscles, so that it would seem that those amœbæ which one finds in the stool with included red blood corpuscles must be amœbæ which have escaped from some definite active lesion of the gut, where they have been living as tissue parasites. These observations lend support to the view which we have expressed elsewhere, that if amœbæ are found with phagocyted red blood corpuscles they are certainly *E. histolytica*, and are taking part in some active dysenteric process, and that such cases without further evidence require emetin or other anti-amœbic treatment.

Only on one single occasion, as we have noted above, has free *E. histolytica* with included red blood corpuscles been found in an ordinary unformed stool which showed no evidence of blood or mucus either micro- or macro-scopically. In this case there were present numbers of rather small amœbæ which were thought to be minuta forms of *E. histolytica*. A search for *E. histolytica* cysts was being made when a large active amœba with several red blood cells within it was found. No cysts were present. The case was diagnosed accordingly and a few days later the diagnosis was confirmed by the finding of numerous cysts of *E. histolytica*.

(7) *Characters and Diagnosis of Cysts of Entamœba coli.*

As regards the cysts of *E. coli* we have very little new information to offer. We have noted, however, greater range in size than has been previously admitted. James, describing *E. coli*, has noted cysts as small as ten microns in diameter. Undoubted *E. coli* cysts as small as this we have not seen. The lowest limit of size has been thirteen or fourteen microns.

We have frequently seen infections in which practically all the cysts were over 20 microns, while once the average size was well over 25, and one cyst circular in outline had a diameter of 32 microns; while on another occasion a cyst measuring 38 by 34 microns was seen. These large cysts often show sixteen instead of the eight nuclei so characteristic of *E. coli*. It is very probable that strains of *E. coli* exist as we have described for *E. histolytica*, one strain differing from another in the average size of its cysts. We have not, however, made any definite measurements to decide this point.

Another feature of the cysts of *E. coli* which demands attention is the possible presence of chromidial bodies. These may be single bars, very like the rods in *E. histolytica* cysts, or they may be multiple when they take on various shapes, being either rod-like, round, oval, or spindle-shaped masses, or more irregular in form. Sometimes in *E. coli* cysts there occur numerous fine filamentous structures which may show a thickening in the centre, so that they are fusiform in shape. These may be arranged irregularly through the cytoplasm with the eight nuclei distributed amongst them, or the eight nuclei may be grouped together in a central mass of cytoplasm, while the fusiform bodies are arranged tangentially around this central mass. The fusiform structures may be few in number, or very numerous. We have some evidence that they are really bacteria which have not been extruded by the encysting amœbæ. The possibility of their being parasites of the amœba has also to be considered.

It has been pointed out before that the type of *E. coli* cyst, most commonly met with in the stools, is the eight-nuclear cyst, while the stage with two or four nuclei is more rarely seen. An exception to this rule, however, is the frequent occurrence of the type of cyst with large central vacuole and only two nuclei. Sometimes nearly every cyst in a stool is of this type. These bi-nuclear, vacuolated cysts are generally quite green in colour, and more refractile than the clear transparent non-vacuolated eight nuclear cysts. It seems to us that there is something abnormal about these cysts, and it still remains to be proved that they are capable of further development. We cannot agree with Kuenen and Swellengrebel that these two-nuclear vacuolated cysts are an essential stage in the development towards the unvacuolated eight-nuclear cysts. As a matter of fact, the one, two, and four-nuclear cysts without the central vacuole are far from uncommon when one happens to get a stool containing the actually encysting amœbæ.

The two-nuclear cysts with central vacuole seem to be derived from certain green highly refractile amœbæ which have a much vacuolated cytoplasm. They are fairly common, and are often seen as green discs of cytoplasm, the central part of which is either a single large vacuole or several smaller ones. The nucleus in these amœbæ may or may not be clearly visible.

Suggestions have recently been made that the distinction between the cysts of *E. coli* and *E. histolytica* are not so definite and marked as some maintain. It has been even hinted that the one may be only a smaller variety of the other. Gauducheau has written that the distinctions between *E. coli* and *E. histolytica* will not hold. We quite admit the difficulty of distinguishing vegetative forms of the amœbæ, and recognize that occasionally there may be some uncertainty even with the cysts, for large strains of *E. histolytica* cysts occur as well as small strains of *E. coli*. *E. coli* cysts may have chromidial bodies, but the presence of four nuclei in the fully developed *E. histolytica* cysts is so universal that one can state with certainty that this is a reliable feature for diagnostic purposes. The *E. coli* cysts when developed have eight nuclei, and sometimes more. The clearest demonstration of the difference of the two cysts is seen in cases of mixed infections treated with emetin where the *E. coli* cysts survive the treatment, and the smaller four-nuclear *E. histolytica* cysts disappear; while in pure *E. histolytica* infections there is a complete disappearance of all the cysts. Such cases are absolutely impossible to explain on any other basis than that the two amœbæ, *E. coli* and *E. histolytica*, represent two distinct species of different characters and habits.

(8) *The Course of E. coli Infections.*

It has already been pointed out by one of us (C. M. W.) that *E. coli* infections may persist for several years. James, working in Panama, mentions a case which constantly showed *E. coli* during a period of about five years. A case of *E. coli* infection which was not complicated by the presence of any other protozoon we have followed very carefully during the last few months. The results of the examinations made during a period of 120 days are shown in the accompanying table below. The character of the stool at each examination and the occasions on which a saline purge was administered are set down, for it will be seen how directly this

affects the finding. Encysted forms were present on most occasions whereas the free unencysted forms were rarely present except when the stool was soft after the saline purge. On the ninety-fifth and ninety-sixth days there was diarrhœa accompanied by a very large blastocystis infection. This case illustrates very well what may be taken as the normal course of an *E. coli* infection judged by the appearances in the stool. This case also had an ankylostoma infection and the days on which eggs of this worm were present are shown in a separate column.

Days	*E. c.c.*	*E. f.*	Ankylostoma	Saline	Stool	Days	*E. c.c.*	*E. f.*	Ankylostoma	Saline	Stool
1	–	+++	+	+	B.l.	43	–	++	+	+	B.uf.
2	+	++	–	–	B.uf.	44	–	–	–	–	B.f.
3	+++	++	+	–	B.uf.	45	++	–	–	–	B.f.
4	++	–	–	–	B.uf.	46	++	–	–	–	B.f.
5	++	–	–	–	B.f.	50	+++	–	–	–	B.f.
6	+	–	+	–	B.f.	52	–	–	–	–	B.f.
7	+	–	+	–	B.f.	56	+	–	–	–	B.f.
11	++	+	+	+	B.uf.	62	++	++	–	–	B.uf.
12	+	–	–	–	B.f.	63	–	–	–	–	B.uf.
16	+	–	–	–	B.f.	65	++	–	–	–	B.f.
17	+	++	–	+	B.uf.	68	–	++	+	+	B.uf.
18	+	–	–	–	B.f.	69	–	+	+	–	B.uf.
19	–	–	–	–	B.f.	74	–	+	+	+	B.uf.
20	–	–	–	–	B.f.	76	+	–	–	–	B.f.
21	–	–	–	–	B.f.	81	+	–	–	–	B.f.
22	–	–	–	–	B.f.	89	++	–	–	–	B.f.
27	+++	+	–	–	B.f.	90	++	–	–	–	B.f.
29	–	–	–	–	B.f.	91	++	+++	++	+	B.uf.
30	–	++	–	+	B.uf.	94	–	–	–	–	B.sf.
33	–	–	–	–	B.f.	95	++	++	+	–	B.l.
38	++	++	+	+	B.uf.	96	++	++	+	–	B.l.
39	–	–	–	–	B.f.	107	+	+	–	–	B.uf.
40	++	–	–	–	B.f.	120	–	–	+	+	B.uf.

B.l. = Brown liquid. B.uf. = Brown unformed. B.f. = Brown formed. B.sf. = Brown semiformed.

On ninety-fifth and ninety-sixth days there was an attack of unknown origin. At this time blastocystis, which had been present in small numbers before, were very numerous indeed. After the attack of diarrhœa had passed off, the blastocystis were again reduced. The table shows the presence or absence of *E. coli* free and encysted, eggs of ankylostoma, the character of the stool, and whether this was the result of a saline purge or not during a period of about four months.

PLATE I.

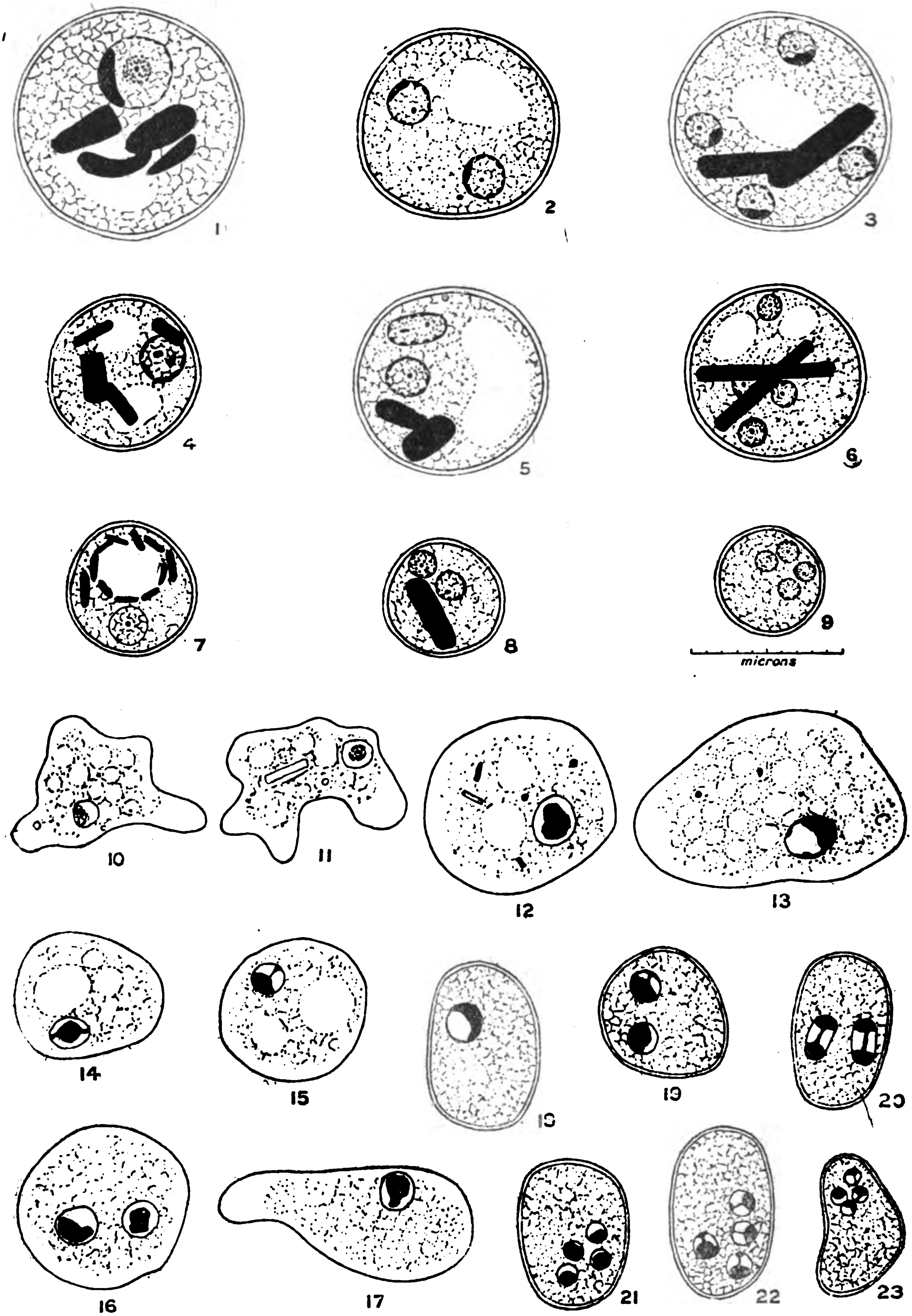
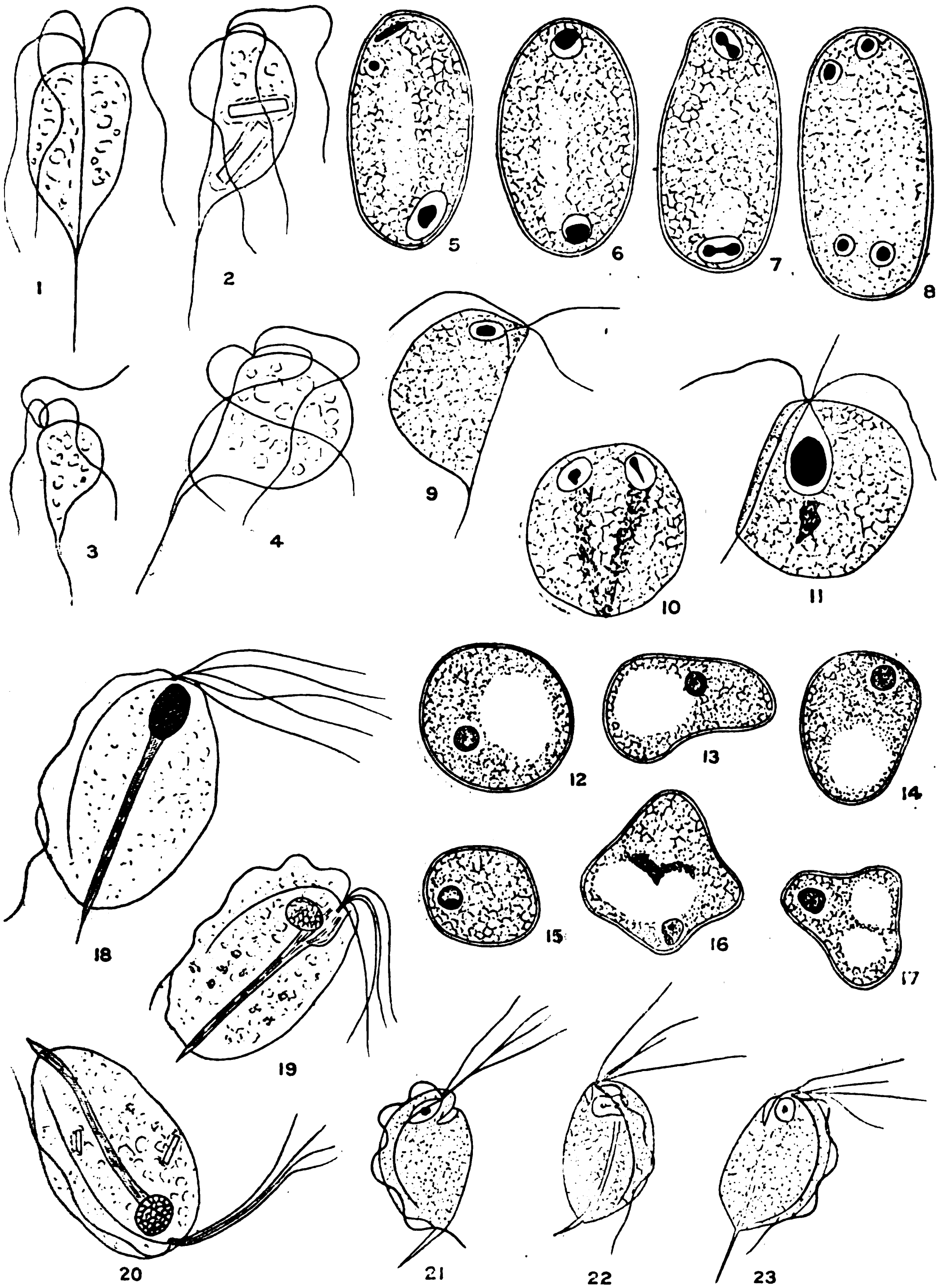


PLATE III.



(9) *Is E. coli ever pathogenic?*

E. coli is the commonest protozoon parasite of the human intestine all the world over, and it is evident that for this reason it must be present in all kinds of intestinal disease. The statement made by Low that it is gradually being borne in upon him that *E. coli* is sometimes pathogenic in causing diarrhœa is of little value as it is backed by no evidence and he does not tell us how long he has been accustomed to control his cases, with a clear idea as to the differential diagnoses between *E. coli* and *E. histolytica*. Because one encounters *E. coli* in a diarrhœic condition one must not be misled into the notion that it is the cause of the trouble. In Egypt the largest infections of *E. coli* we have encountered, and some of these very large indeed, have been in perfectly healthy men with normal stools. Further, taking into consideration a large series of hospital cases with diarrhœa the percentage of *E. coli* infections is considerably below that of healthy men in the same locality. The cases which have intestinal symptoms of diarrhœa with an *E. coli* infection invariably retain the *E. coli* infections when they recover, and as will be seen from the records of the *E. histolytica* infections treated by us, the *E. coli* infection almost invariably remains after the *E. histolytica* has disappeared. Of greatest importance however from the point of view of the pathogenicity of *E. coli* are the cases of infection which have been followed for very long periods. It is impossible to state that these individuals never have attacks of diarrhœa at any time, for who does not at some time or another during the course of every year, especially in a warm climate? But it can be definitely asserted that they show no abnormal tendency to diarrhœa. There is, therefore, in our opinion no justification for regarding *E. coli* as pathogenic.

A note of warning may perhaps be sounded for the benefit of those medical men to whom the subject of the intestinal protozoa of man is a new one. Those who have not been accustomed to study these organisms in any detail, and have only recently begun clearly to differentiate between them, must not be led astray by their comparative attractiveness and large size. The great majority who examine for intestinal organisms do so only in the case of sick people who have some intestinal disorder, and they have no means of comparing their findings with what occurs in healthy individuals. Accordingly it seems quite natural to them to attribute to the intestinal protozoa, both amœbæ and flagellates, which are com-

paratively easily recognized, pathogenic powers which they may not possess. It seems to us that there is only one possible plan of arriving at a safe conclusion as regards the relative frequency of protozoa in healthy and sick people, and it is one which is hardly practicable on a large scale. It is to take a large series of healthy individuals and to examine their stools for about one week while they are being purged by means of salines and to compare the results thus obtained with those from a similar series which are suffering from diarrhœic conditions acquired naturally. In this manner the relative incidence of some of the amœbic and flagellate infections in healthy and diarrhœic subjects might be obtained.

(*To be continued.*)

THE ELECTRICAL REACTION OF MUSCLES BEFORE AND AFTER NERVE INJURY.

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(*Continued from p.* 65).

Case 7.—This is the case of a patient aged 28, who had an attack of acute poliomyelitis on October 8, 1915. The paralysis remained in the trunk, right arm and legs. He was examined on December 27, 1915. At this state the left tibialis anticus had moderate voluntary power, but did not react to faradism applied in

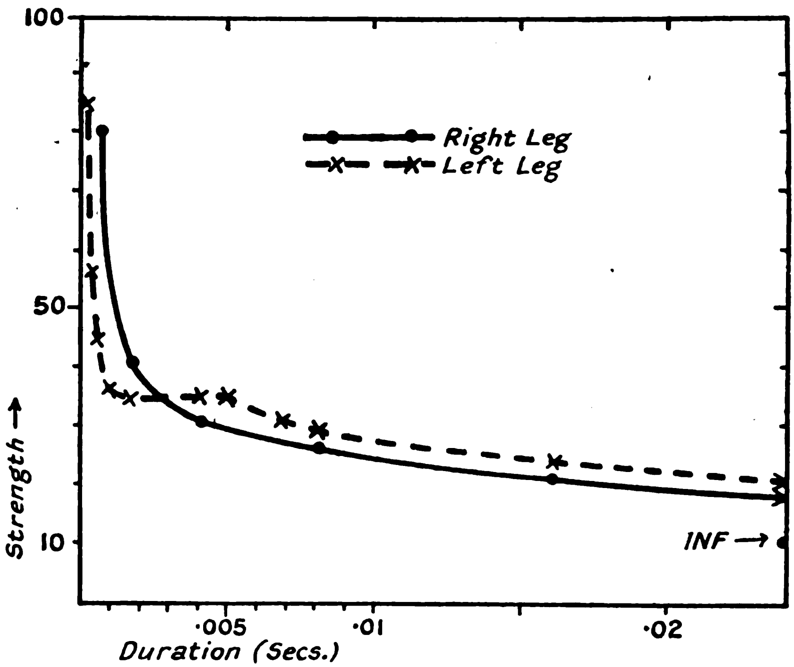

Fig. 8.

the region of the motor point unless a very strong current was used. It reacted more readily when the current was applied lower down the leg. The right tibialis anticus had no voluntary power at all and did not react to the strongest faradic currents which could be

used. Fig. 8 shows the curves for both legs with the cathode applied high up near the motor point. That for the left tibialis anticus is drawn as an interrupted, and that for the right as an unbroken line. The right is a continuous curve, but the left shows a discontinuity when the strength is increased to 34 and the duration reduced to 0·0056 second. With smaller durations the strength

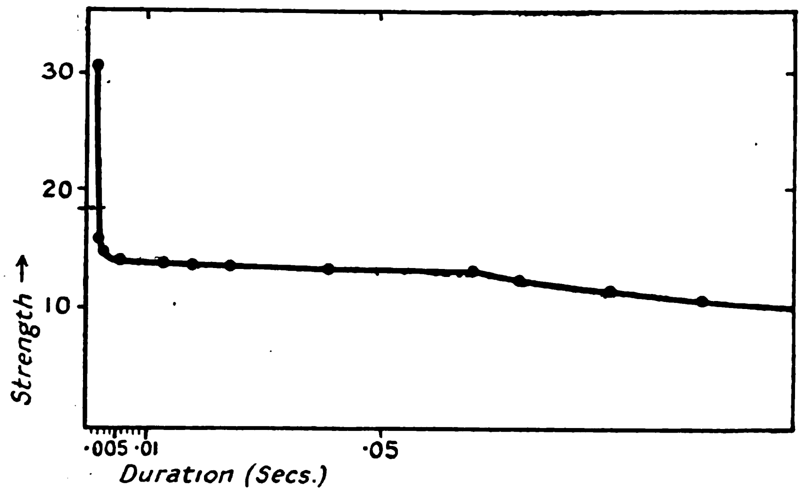

Fig. 9.

remains constant and does not rise again until the duration is in the neighbourhood of 0·0004 second. Fig. 9 shows the curve for the left tibialis anticus with the electrode at a lower level. The curve rises gradually until the duration is reduced to 0·064 second and then remains constant at a strength of 14 until the duration is in the neighbourhood of 0·0004 second, after which it rises steeply.

Case 8.—The patient had an attack of toxic polyneuritis of unknown origin in August, 1915. To begin with both arms and legs were paralysed, but when he was examined he was recovering rapidly, had fair voluntary power in the arms and could walk for a short distance unaided. In spite of this the leg muscles showed no response to strong faradic currents, and gave the typical reaction of degeneration with galvanic currents.

The curve for the tibialis anticus on each side is shown in fig. 10. The curve for the right leg is an unbroken line, and that for the left is interrupted. Both show a discontinuity, that on the left occurring when the strength is 20, and that on the right when the strength is 31.

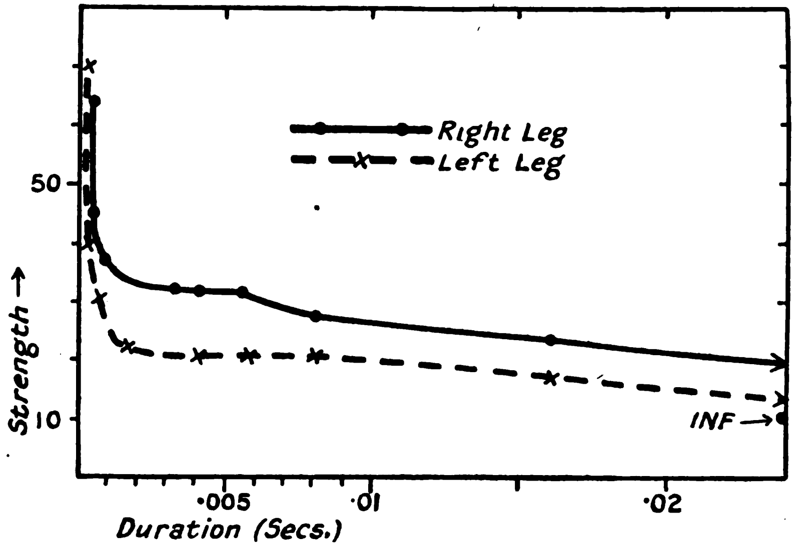

Fig. 10.

Case 9.—The patient was shot through the right thigh in May, 1915. Immediately after the injury the leg was completely paralysed below the knee, and there was complete loss of sensation over the area supplied by the sciatic. There was some return of voluntary power in the calf muscles in September, but the tibialis anticus was still paralysed. The reaction to faradism was not determined. The strength duration curve was determined on September 24 and again on October 7. At the first determination the current strength was not increased above 20; below this strength the curve is continuous and the chronaxie is 0·004 second. Fig. 11 shows the curve on October 7. There is a discontinuity at a strength of 24 and a duration of 0·0024 second. The lower part of the curve agrees in all respects with that determined on September 24. A study of figs. 6 to 11 shows that there are certain common features in the strength-duration curves of all the muscles which gave evidence of recovery. In every case the curve is discontinuous and appears to be composed of two curves of the same form but with very different time constants. The lower curve rises gradually at long durations; the upper starts from a higher base line and does not begin to rise until the duration is very short. The point of intersection of the two curves varies widely, but it would appear from figs. 6 and 7 that it occurs at weaker strengths and longer durations as the condition of the paralysed muscle improves. If the

time constants of these curves are determined it is clear that the upper curve has a short chronaxie which approximates closely with that for healthy muscle with intact nerve supply. In fact, the

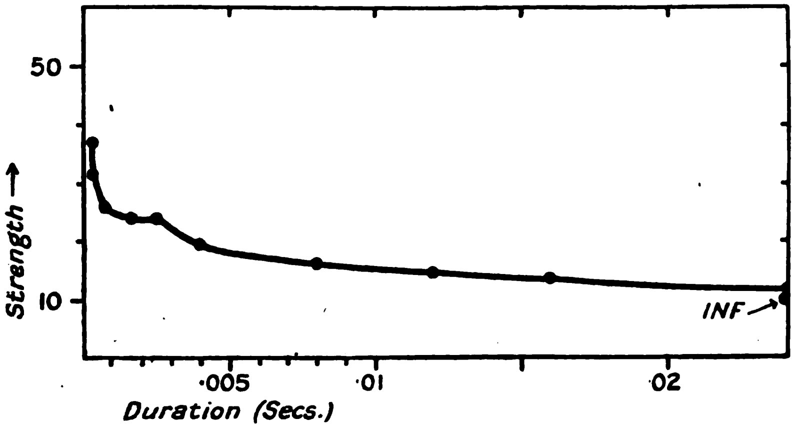

FIG. 11.

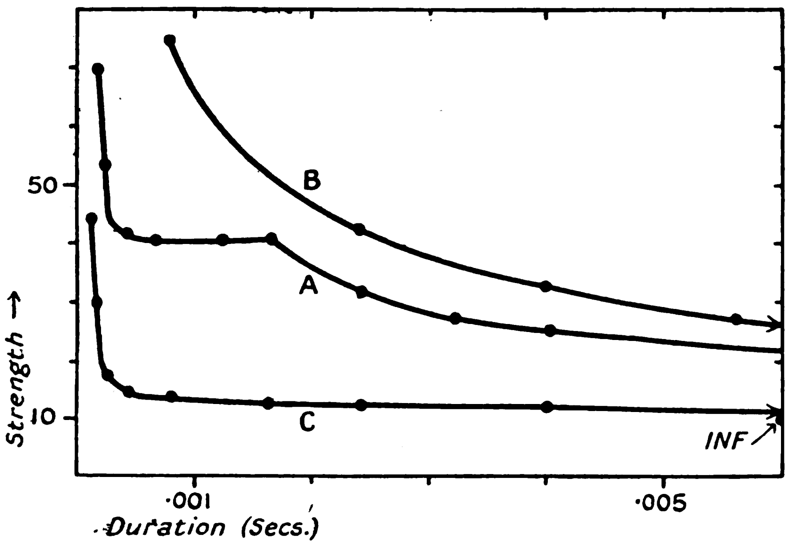

FIG. 12.

only point of difference between the curve for healthy muscle and the upper portion of these complex curves lies in the greater current strength needed in the case of the incompletely recovered muscle.

Again the lower half of the complex curve is very much like the curves for completely denervated muscle. The chronaxie of this part of the curve is certainly much more variable than the chronaxie after division of the sciatic, but the figures are of the same order in both cases. A good example of this agreement is shown in fig. 12. In this figure the curve marked *a* is that for the right tibialis anticus in Case 6 (fig. 7) on a larger scale, *b* is a typical curve for denervated muscle (Case 1, fig. 4), and *c* is a curve for muscle with intact nerve supply. If the curve *c* could be made to rise from a higher base line it is easy to see how the complex curve might be produced by a combination of the curve for intact with that for denervated muscle. There is certainly no sign of any gradual transformation of the curve for denervated muscle into that for healthy muscle, and this holds good for every case investigated.

TABLE III.

COMMENCING RECOVERY AFTER PARALYSIS

Case			Chronaxie of lower curve		Chronaxie of upper curve
6 ..	November 27 ..	Right	0·011	second ..	0·00008 second.
		Left	0·008	,, ..	0·00014 ,,
	December 8 ..	Right	0·008	,, ..	0·00016 ,,
		Left	0·010	,, ..	0·00012 ,,
	,, 26 ..	Right	—	..	—
		Left	0·0095	,, ..	0·00016 ,,
7 ..	— ..	Right	0·016	,, ..	—
		Left, (*a*)	0·020	,, ..	0·00010 ,,
		(*b*)	0·020	,, (?) ..	0·00012 ,,
8 ..	— ..	Right	0·020	,, ..	0·00024 ,,
		Left	0·0095	,, ..	0·00040 ,,
9 ..	September 24 ..	—	0·004	,, ..	—
	October 7 ..	—	0·004	,, ..	0·00012 ,,

Extreme values $\left\{\begin{matrix}0{\cdot}020\\0{\cdot}004\end{matrix}\right\}$ Mean, 0·011 sec. Extreme values $\left\{\begin{matrix}0{\cdot}0004\\0{\cdot}00008\end{matrix}\right\}$ Mean, 0·00016 sec.

For denervated muscle (Table II) the corresponding values are:—

Extremes $\left\{\begin{matrix}0{\cdot}013\\0{\cdot}0095\end{matrix}\right\}$ Mean, 0·011 sec.

For muscle with intact nerve supply (Table I) the values are:—

Extremes $\left\{\begin{matrix}0{\cdot}00025\\0{\cdot}00008\end{matrix}\right\}$ Mean, 0·00016 sec.

The time constants of all the double curves are shown in Table III. The chronaxie of the slower curve is determined in the usual way, i.e., it is the duration corresponding to a strength twenty, twice that at infinite duration. To determine the chronaxie of the more rapid part of the curve the strength required when the discontinuity

appears is supposed to be the strength at infinite duration. This amounts to the assumption that the rapid curve if it could be investigated at long durations would not fall appreciably below the value corresponding to the horizontal part of the curve. On this assumption the chronaxie is the least current duration required when the strength is twice that corresponding to the horizontal part of the curve. In some cases this must be found by extrapolation as the actual strengths of current were not great enough.

The table brings out very clearly the agreement between the rapid part of the complex curve and the curve for muscle with intact nerve supply. The slower part of the curve agrees more or less with that for completely denervated muscle, but the close agreement of the average values is to some extent fallacious, since the extremes show a much wider variation in the case of incompletely recovered muscle than they do in denervated muscle.

Interpretation of Results.

We have seen that in muscle with intact nerve supply and in denervated muscle the strength-duration curve is of a constant form, but that the time constant is much greater in the case of denervated muscle than it is in intact muscle. Further, the results obtained on muscles which are recovering from incomplete nerve lesions make it clear that the slow curve characteristic of denervated muscle does not return gradually and without any discontinuity until it approximates to that for intact muscle. Instead of this the curve for recovering muscle is complex and is always made up of two distinct curves, of which the slower corresponds more or less with that for denervated muscle and the more rapid with that for intact muscle. In the earlier stages of recovery the more rapid curve does not appear until the current strength is several times the minimal value. As recovery progresses the rapid curve becomes evident with weaker and weaker current strengths until eventually it would seem to oust the slower curve altogether.

This result is of very great importance, for it shows that during recovery the current takes effect upon two distinct excitable mechanisms with very different time constants. At first sight it might seem possible to explain this on the assumption that the current affected two groups of muscle fibres in different states of recovery. In poliomyelitis the different fibres of a paralysed muscle do not always recover at the same rate, and a part of the muscle may have voluntary power and response to faradism while

the rest is completely paralysed and responds to galvanism only. These fibres might be so intimately mixed that it would be impossible to distinguish one set from the other by mere palpation. Consequently the strength duration curve might be composite because it was made up of curves for several sets of muscle fibres in different stages of recovery. However, if this were the case, we should expect to find not one discontinuity in the curve but several. In fact there would be as many discontinuities as there were different stages of recovery in the fibres under investigation. Moreover, there would certainly be curves in which the time constant had a value intermediate between that for denervated muscle and that for muscle with intact nerve supply. Neither of these possibilities is realized in figs. 6 to 11. The only other possible explanation is that the mechanism upon which the current takes effect in muscle with intact nerve supply is quite distinct from that in denervated muscle, and that the great difference in the time factor in the two cases is not due simply to an alteration in the conditions of one and the same mechanism. On this hypothesis the recovery of the muscle is shown by the appearance of the mechanism characteristic of normal muscle in addition to the mechanism characteristic of denervated muscle. In the earlier stages of recovery the former mechanism needs a much stronger current to excite it than does the latter, but as recovery progresses the rapid mechanism becomes more and more excitable until eventually it replaces the slower mechanism altogether.

It is not difficult to find a satisfactory explanation of the nature of these two mechanisms. In the frog, Lucas and Lapicque have shown that the nerve fibres in the trunk of the sciatic and the nerve fibres in the substance of the sartorius and gastrocnemius react to much more rapid currents than do the muscle fibres excited directly. Now the great difference between normal muscle and denervated muscle lies in the fact that the former possesses healthy nerve-fibres running in the substance of the muscle, whereas the latter does not. Evidently in normal muscles there are two distinct excitable mechanisms, the nerve-fibre and the muscle-fibre, whereas in denervated muscle there is one mechanism alone. From the results obtained on the frog we should expect that the nerve-fibres would have a much shorter chronaxie than the muscle-fibres, and hence it is easy to see why the intact muscle gives a much shorter chronaxie than the denervated muscle.

During recovery from injury to the nerve, traumatic or toxic, the intra-muscular nerve-fibres become active again, but at first

we may suppose they are less excitable than usual. Under these circumstances we should expect to find a double curve, weak currents of long duration affecting the muscle-fibres directly and strong currents of short duration affecting the intra-muscular nerve-fibres. A process of this kind has been demonstrated experimentally in the frog's sartorius by Keith Lucas. The strength duration curve of this muscle may be either a rapid curve characteristic of the nerve-fibres or a slower curve characteristic of muscle, or else a double curve showing both components. The type

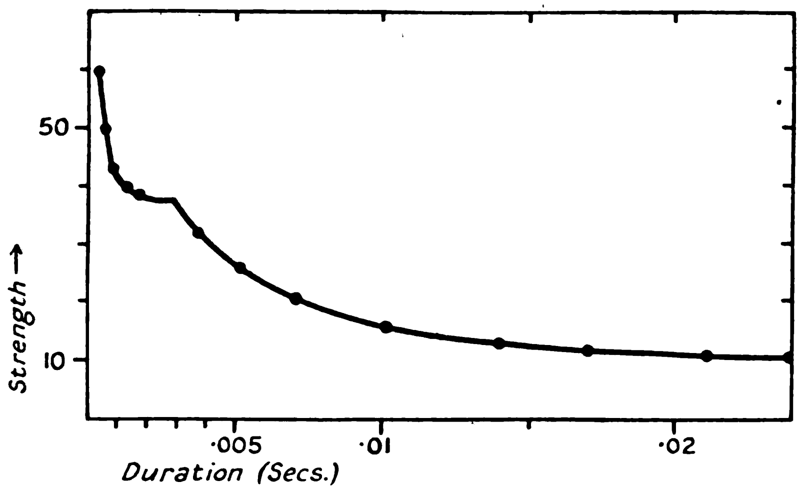

FIG. 13.

of curve in any particular case depends on the relative excitability of the nerve and muscle-fibres and on the distribution of the muscle-fibres in the neighbourhood of the electrodes. When the muscle is treated with curare the nerve-fibres gradually cease to transmit impulses to the muscle and consequently the more rapid component of the curve disappears, to return again when the effect of the curare works off. Fig. 13 shows a double curve obtained by Lucas,[1] from the sartorius of the frog and the resemblance between this and the curves for human muscle in figs. 6 to 11 is self-evident.

So far, then, the explanation is simple enough. However, there are one or two points which call for further discussion. In the

[1] *Journ. of Physiol.* xxxv, p. 323, 1907.

first place the mechanism which has been excited by currents of short duration has been identified with the intramuscular nerve fibre. If this is so, we should expect to obtain a curve with the same constants when the current is applied to the nerve trunk instead of to the muscle itself. The average value of the chronaxie when the kathode is applied to the external popliteal worked out at 0·00025 second for four different cases. This is slightly longer than the value for the tibialis anticus. The difference may, of course, be due to experimental error. However, there is another possible explanation which deserves mention. In the frog's muscle, in addition to the muscle and nerve fibres, Lucas has shown that there is a third excitable substance which appears to correspond in distribution with the nerve endings in the muscle. This substance has a shorter time constant than the muscle fibre, the chronaxie being 0·00017 second as against 0·0005 second, for the nerve. In the case of human muscles it is conceivable that a current applied to the muscle may excite a mechanism in the nerve endings rather than in the intramuscular nerve, and this may explain the slower value of the chronaxie for the nerve trunk. However, in the absence of more reliable figures, this cannot be insisted upon.

There is another possibility which must be discussed shortly. It is sometimes held that voluntary muscle is made up of two components, a fibrillar substance which reacts rapidly and a sarcoplasmic substance which reacts slowly. These two substance might perhaps be identified with the two excitable substances in human muscle, the fibrillar substance disappearing when the nerve degenerates. However, the idea has little or nothing in its favour. The separate existence of the fibrillar and the sarcoplasmic substances has never been proved, and there is nothing to show that they have the distinct properties with which they are credited. Furthermore, the electric reactions of the cold-blooded tissues are certainly due to the effect of the current on muscle fibres and nerve fibres, and it is difficult to believe that the reactions in human muscle are due to an entirely different mechanism. Much the same objection may be brought against the view that the two excitable mechanisms are to be identified with the white and red fibres of the muscle. It is true that the existence of these two sets of fibres is not in doubt, and it is true also that the white fibres degenerate more rapidly than the red. Again the white fibres give a brisker contraction when they are stimulated, and therefore they might well react to currents of shorter duration. In human muscle the two types of fibre are intimately mixed, and so

we might expect to find evidence of two different constants in the strength-duration curve. However, we have seen that the chronaxie of the rapid component of the double curve is equal to or slightly shorter than that of the nerve trunk itself. This in itself is very much against the suggestion that the rapid curve is due to the white muscle fibres rather than the nerve fibres or nerve endings, for, setting aside the comparatively close agreement between the chronaxie of the rapid curve and that of the nerve, no other case is known in which a muscle fibre has a time constant equal to or shorter than that of the nerve fibre which supplies it. Moreover, if the short chronaxie were due to the white muscle fibres, we should not expect it to disappear until the muscle showed definite signs of wasting, or to reappear until the wasting began to improve. Consequently we must revert to the idea that the two mechanisms in question are the muscle fibre and the nerve fibre.

A further point of interest concerns the value of the chronaxie for denervated muscle. After complete section of the sciatic, the chronaxie always lay between 0·013 and 0·009 second, and it has been suggested that this value is characteristic of muscle fibre excited directly. It is naturally impossible to verify this by direct experiment on a human subject, as the effect of the nerve fibres would have to be eliminated by curare or some such means. In the frog the chronaxie for muscle fibre is about 0·007 second, at 15° C., although we might naturally expect it to be longer than that for the muscles of a warm-blooded animal. This suggests the possibility that the chronaxie for human muscle fibre would be really shorter than 0·01 second if it could be measured when the fibre was in a healthy condition, and that after the nerve is destroyed the chronaxie becomes longer on account of the abnormal state of the muscle. This view is upheld by the fact that in Case 9, where the nerve injury was incomplete, the chronaxie of the slower component of the curve was 0·004 second, a value which is less than half the average for denervated muscle. In spite of this, it seems on the whole more probable that the figure of 0·01 second is the average value for muscle fibres, and that the short value in Case 9 is due to an individual peculiarity, and not to the improved condition of the muscle. If this were not the case, we should expect the chronaxie to become longer and longer with the lapse of time following section of the nerve. The figures in Table II show that this lengthening does not occur. Again, in Case 7 (poliomyelitis) the chronaxie of the lower part of the curve is 0·02 second, although there was some return of voluntary power

in the muscle, aud although the chronaxie for the other tibialis anticus, which did not show any sign of recovery, was only 0·016 second. Consequently the restitution of functionally active nerve fibres is certainly not followed by an immediate shortening of the chronaxie for muscle fibres. This does not imply that the chronaxie for muscle does not become longer as the muscle wastes, and becomes converted into fibrous tissue. The muscles examined in Table II had all been treated by massage and electricity, and they showed very little wasting; on the other hand, in a few cases of ulnar and median injuries, with marked wasting of the small muscles of the hand, the chronaxie appeared to be considerably longer, 0·025 or 0·03 sccond at least. These results are only rough approximations, as the method is very uncertain when applied to small denervated muscles in close contact with small healthy muscles. Still, no doubt, the chronaxie of human muscle fibre may vary from 0·004 second to 0·03 second or longer, according to the state of the tissue. The important fact remains that functional connexion with the central nervous system may be restored, although the chronaxie of the muscle fibres is twice as long as the average value for denervated muscle. The precise bearing of this result will be seen in the following section.

The conclusions arrived at in the present section may be stated briefly as follows: In muscle with intact nerve supply there are two distinct mechanisms upon which an electric current may take effect. These mechanisms are: (*a*) the intramuscular nerve fibres, and (*b*) the muscle fibres themselves. The nerve fibre responds to currents of much shorter duration than the muscle fibre, and in healthy muscle the strength-duration curve is always continuous and characteristic of nerve fibre alone. In muscle, which is in process of recovery after a nerve lesion, the curve is discontinuous, and is made up of two simple curves, one with the short-time constant characteristic of nerve, and the other with the long-time constant characteristic of muscle. After complete degeneration of the nerve, the curve is continuous, and has the long-time constant characteristic of muscle. The constant may vary with the condition of the muscle, but its precise value does not affect the possibility of reunion with the nerve.

The Bearing of these Results on Diagnosis and Prognosis.

If we accept the foregoing interpretation of the changes which follow injuries to the nerve, we can draw certain conclusions regarding the possibility of electrical testing in general without

reference to any particular method. For instance, it is clear that after a lesion which has produced complete degeneration of the nerve fibres, the electric reactions of the muscle itself can give no information at all as to the state of the nerve at the site of the injury. All we can hope to decide is whether the muscle is or is not in a fit state to recover its voluntary power when the nerve fibres have regenerated. We cannot tell whether the lesion is one which makes regeneration impossible and therefore demands operation, or whether regenerated fibres are already growing down towards the muscle. The present observations show that the condition of the muscle itself, as indicated by the time constant, is of no great importance. It may remain for long periods unchanged after the complete degeneration of the nerve, and voluntary power may return although the constant is twice as long as that six months after complete section (Case 7). The all-important factor is the condition of the nerve at the site of injury and this we cannot hope to determine by electrical methods.

The position is altered when there are some nerve fibres peripheral to the lesion which retain or have regained their excitability to electric currents. The presence of these fibres may be detected from the complex nature of the strength-duration curve and the production of a response in the muscle to currents of very short duration. If these fibres become more and more easily excitable it is safe to assume that the condition of the nerve is improving. In such cases the determination of the electric constants would show that the prognosis was favourable. However, these determinations would be of value only in those cases in which the possibility of recovery could not be deduced by simpler methods. For instance, if there is any return of voluntary power in the muscle there is clearly no need of an electrical examination to tell us that some of the nerve fibres have regained their function. In three out of four of the cases of commencing recovery which were examined by the present method, the return of a slight degree of voluntary power appeared to coincide with the reappearance of the curve with the short time constant and therefore with the reappearance of nerve fibres which would respond to stimulation by electricity. In the fourth case (gunshot wound of the right thigh, Case 9) the strength-duration curve showed that some of the nerve fibres could be excited electrically although there was no return of voluntary power in the tibialis anticus. Even so the electric constants were not needed to show that the nerve was recovering as there was already a considerable return of power in

the calf muscles. Nevertheless in so far as its history is concerned the case is typical of a large number of incomplete nerve injuries caused by gunshot wounds, in which the paralysis clears up without operation and much more rapidly than it should do if the nerve fibres below the site of injury had degenerated completely. In these cases it is evident that the nerve fibres below the injury must be still in some kind of trophic connexion with the motor cells in the cord though they are unable to transmit impulses from the central nervous system to the muscle. Unfortunately Case 9 was the only one of this class of injury which could be investigated by the present method, but it is not unreasonable to suppose that most if not all of them would agree with it in showing evidence of nerve fibres peripheral to the lesion and yet capable of responding to electric stimuli. If so the determination of the strength-duration curve would give valuable evidence of the likelihood of recovery. When the curve does not show the characteristic discontinuity, we can only say that the nerve fibres peripheral to the injury are inexcitable and that the possibility of recovery must remain in doubt. In such a case we may say with certainty that there is no method of electrical testing which will help to solve the question, since the current takes effect on the muscle fibres alone and the state of the muscle fibres gives no indication of the state of the nerve.

In conclusion we may say that a certain prognosis can be given only in those cases in which the nerve fibres peripheral to the injury retain some measure of excitability. The presence of such fibres is shown by the complex type of strength-duration curve and the efficacy of currents of very short duration. How far their presence may be detected by the simpler methods of testing in vogue at present is a question which will be discussed in the following section.

The value of these results in diagnosis is another matter. To a certain extent any method of diagnosis which gives additional information as to the state of a diseased tissue must be counted of value even though the information has no direct bearing on the treatment and prognosis of the case. The strength-duration curve gives definite information as to the state of the excitable mechanisms in nerve and muscle fibre and this information may be expressed in a quantitative form. Furthermore Lapicque, Keith Lucas and A. V. Hill, have put forward theories as to the nature of electric excitation in which the constants of the strength-duration curve are given definite physical interpretations. These theories

are based on Nernst's[1] original hypothesis that, in order to excite, the current must bring about a certain concentration of ions at the surface of a semi-permeable membrane in the substance of the fibre. Thus in Hill's theory the constants of the curve enable us to tell the charge on the ions, their rate of diffusion, the distance separating the membranes on which they take effect and the degree of concentration which must be attained in a given time for excitation to take place. These may be calculated as readily in the case of human excitable tissues as in those of the frog, and in this way it should be possible to relate a change in the condition of the muscle to a change in the diffusibility of the effective ions or the degree of concentration which must be attained at the membranes, etc. No attempt has been made to treat the present results in this way, because they are too few for such an elaboration and because the present theories of excitation are admittedly incomplete and in need of alteration. For the present it must suffice to point out the possibilities of exact diagnosis which might be made on these lines.

Present Methods of Electrical Testing.

We have seen that the most important function of electrical testing is to determine the presence or absence of excitable nerve fibres peripheral to the damaged area. If these fibres are present some weeks after the injury the prognosis is good and recovery may take place without operation. If they are absent the prognosis is uncertain, but there is evidently no need to delay operation. It follows that the different methods of electrical testing must be valued according to their ability to detect these fibres. When the complete strength-duration curve is determined the presence of active fibres is shown by the complex type of curve and the response to currents of very short duration. A current of 0·0004 second will excite nerve fibres if it is strong enough, but it will not excite muscle fibres however strong it may be. So if we could always use a current of this duration and of variable strength, there would be no need to determine the full curve. It remains to be seen how far this may be done with the methods in use at present.

(1) *The Faradic and Galvanic Current.*—At first sight it might appear that the ordinary method of testing with the induction coil would be accurate enough, since the faradic current is of such

[1] *Arch. f. d. ges. Physiol.*, cxxii, p. 275, 1908.

a duration that it will excite nerve but not muscle fibre. However, it is evidently not at all suited to detect the presence of nerve fibres if these are relatively inexcitable. It is well known that a muscle may regain some degree of voluntary power long before it shows any response to faradism, and in such a muscle there must be some functionally active nerve fibres. Such a condition was found in all the cases of incomplete recovery described in this paper. The explanation of this state of affairs may be seen from fig. 7. In this case both legs had some return of voluntary power and the left tibialis anticus reacted slightly to faradism whereas the right did not react at all. The strength-duration curves show that active nerve fibres are present in both muscles, but in the right leg the current must have a strength of 40 if it is to affect the nerve, whereas in the left it need not be stronger than 29. With a short duration it is quite possible to employ a constant current of strength 40 or more without causing much pain because the whole of the current is effective in stimulating the tissue. However, a faradic current of equal stimulating effect would be far too painful because the useful part of the current is only that fraction of the discharge when the electromotive force is at or near its maximum, and the remainder adds to the pain without taking any effect on the excitable tissue. Consequently the right tibialis anticus was put down as inactive to faradism because it was inactive to faradic currents of a strength which could be borne by the patient without an anæsthetic. Presumably the same holds good for every case in which there is voluntary power but no response to faradism. The nerve fibres need a strong current to excite them and a faradic current of this strength cannot be tolerated because of the pain it would cause.

(2) *The Condenser Method.*—This is clearly superior to the induction coil method because it is possible to select the duration of the discharge as well as the strength. Indeed, with some elaboration, it would be possible to map out the full strength-duration curve with a series of condensers of different capacities The discharge is more painful than that of a constant current because the electromotive force falls off rapidly and the latter half of the discharge is useless. The duration of the discharge depends on the total resistance in the circuit as well as in the capacity of the condenser, but for practical purposes the difference in the resistance of two similar limbs is not great enough to matter. Consequently it should be quite possible to select a capacity which would affect nerve fibres without affecting muscle and to use this

for detecting the presence of active nerve fibres in incomplete lesions. It would be necessary to have some means of varying the strength of the discharge, or else to use a discharge so strong that there would be no chance of missing relatively inexcitable nerve fibres.

The ordinary method of using condensers gives information of very doubtful value. If the muscle will respond to discharges of very short duration, 0·05 mf. or less, we may safely infer that the nerve contains active fibres, but if a longer discharge is necessary, its precise value tells us nothing unless we know also the strength of the discharge relative to the strength required when the duration is infinite. If we do not know this we cannot fix even one point in the strength duration curve, and a change in the least capacity required to excite might be due to nothing more important than a change in the general excitability of the tissue brought about by increased skin resistance or excess of fluid in the subcutaneous tissues.

Consequently, there is nothing to be gained by stating the fact that a muscle responds to the discharge of a condenser of, say, 1 mf. capacity unless we can add that the strength required must be a definite multiple of that required at infinite duration. Without this information it is clearly quite impossible to determine the constants of the tissue.

(3) *Otto May's Method.*—This method[1] has not come into general use, but it is interesting from a theoretical point of view. May uses Leduc's commutator for delivering a series of constant currents of short duration at definite intervals and determines the duration at which the contraction of the muscle is at its maximum. This duration becomes longer when the nerve is destroyed. Unfortunately, the height of the contraction depends on very many factors, all of which might be influenced in one way or another by alterations in the nerve supply. For instance, the height of the contraction will depend to some extent on the number of stimuli which take effect within a given time, on the rate at which the contraction develops and subsides, on the refractory period of the tissue, etc. The optimal duration of a series of discharges is certainly related to the state of innervation of the muscle, but owing to the many factors involved it becomes well-nigh impossible to deduce the precise condition of the tissue from the data given

[1] *Brain*, 1913.

by May's method. In addition to this there is a certain amount of practical difficulty in measuring the strength of the contraction, though no doubt this could be overcome if the method were likely to afford information of much value.

(4) *Laugier's Method*[1].—This amounts to an attempt to determine the constants of the strength-duration curve by means of two stimuli of different duration. These are furnished by the make and break shocks of an induction coil, since the durations of these shocks are fixed quantities depending on the dimensions of the coil, and the duration at make is several times as long as that at break. A comparison of the strengths of current required to excite at make and at break gives a quantity which Laugier calls the *indice de vitesse* of the tissue and which is proportional to the slope of the strength-duration curve between the points corresponding to the durations of the make and break shocks. The index is not affected by simple changes in the excitability of the tissue, and a change in the index always denotes a change in the slope of the curve. The method is ingenious and simple to apply, but it is based on a misconception of the changes which take place when the nerve is damaged. If the rapid curve characteristic of normal muscle were transformed gradually and without discontinuity into the slow curve of denervated muscle and vice versa the slope of the curve between two fixed points should give all the information necessary to determine the condition of the tissue. However we have seen that the transition is abrupt and that the two curves are quite distinct, the rapid curve becoming more and more prominent as the process of recovery advances. When the curve is discontinuous the slope between two fixed points will depend on the position of these points in relation to the discontinuity, and although a change in the slope will imply a change in the complex curve, the notion of the *indice de vitesse* loses its simplicity and is no longer a quantity definitely related to the constants of the tissue under examination.

Practically the method has the disadvantage that it cannot be applied to a muscle which has lost its excitability to faradic currents, since the stimuli are necessarily of very short duration: In any case it cannot be said to take the place of the complete determination of the strength-duration curve, since the double curve cannot be defined by two points only, whatever may be the durations corresponding to these points.

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[1] *Brain*, 1913.

SUMMARY.

The curve which expresses the relation between the least strength and the least duration of the current required to excite has the same form for human tissues as it has for the tissues of cold-blooded animals. The time constant of the curve is determined by the duration at which the current strength must be twice the minimal value. This duration is characteristic of the tissue examined and it has been named the "chronaxie." In healthy muscle with intact nerve supply the chronaxie is very short, 0·00016 second on the average, and it is slightly longer when the electrode is applied over the nerve trunk instead of to the muscle directly. When the nerve has degenerated the chronaxie is very much longer. Its average value is 0·011 second, and, in the case of the tibialis anticus at any rate, it shows surprisingly little variation with increased lapse of time following the injury. When the muscle is in process of recovery the slow curve of denervated muscle does not pass gradually into the rapid curve of healthy muscle; instead of this the first sign of recovery is marked by the appearance of a discontinuity in the strength-duration curve. With very strong currents the curve has the short time constant characteristic of healthy muscle, but with weaker strengths a slower curve appears and this has the long time constant of denervated muscle. The production of these double curves shows that there are two distinct mechanisms upon which the current may take effect; only the slower mechanism is present in denervated muscle, and as recovery takes place the more rapid mechanism comes into play and eventually predominates to the exclusion of the slower mechanism. Reasons are given for the belief that these two mechanisms are to be identified with the muscle fibre and the nerve fibre or nerve ending. Thus the appearance of the discontinuity in the strength-duration curve and the response to currents of very short duration shows that there are some excitable nerve fibres peripheral to the injury. This is to be expected in those cases of incomplete injury where the trophic influence of the nerve cells is not abolished although impulses cannot pass from the central nervous system to the muscle. When the curve is continuous and has the slow chronaxie only, all that can be said is that there are no excitable nerve fibres peripheral to the injury. The possibility of regeneration depends on the state of the nerve at the site of injury and this cannot be determined electrically. The condition of the muscle is not of very great importance, for voluntary power may begin to return although the chronaxie of the muscle fibres is twice

as long as it is nine months after complete degeneration of the nerve. It follows that the most important function of electrical testing is to decide whether there are any excitable nerve fibres peripheral to the injury. If there are, and if they are becoming more excitable, then there is no need to operate, if not we cannot tell whether the nerve will regenerate or not and there is no reason to delay operation.

The different methods of testing in vogue at present give some information as to the presence or absence of these fibres. The method of condenser discharges is the most reliable, but the usual method needs several modifications; in particular the strength of current must be a definite multiple of that required at infinite duration, otherwise a change in the general resistance of the limb, etc., may be mistaken for a change in the time constant of the muscle.

The present investigations were carried out on the military cases at the National Hospital for the Paralysed and Epileptic, Queen Square, and I am deeply indebted to the medical and surgical staff of the hospital for allowing me to make use of these results.

TRENCH FEVER: A RELAPSING FEVER OCCURRING AMONG THE BRITISH TROOPS IN FRANCE AND SALONICA.

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After all examples of the well-defined acute fevers had been separated from the cases of fever occurring in the British Armies in France and in Salonica, a considerable number remained in which the diagnosis was doubtful. A few were probably due to infection with the *Bacillus paratyphosus* or even the *B. typhosus*, although all bacteriological examinations had proved negative, but I do not think that these should amount to more than 5 per cent of the cases in which bacteriological confirmation is obtained. The cases left over are most frequently diagnosed as "pyrexia of unknown origin," influenza and rheumatic fever, the first of these being the only diagnosis which is indisputably correct. A small number of cases of true influenza with the characteristic catarrhal and general symptoms undoubtedly occur, although an attempt is rarely made to confirm the diagnosis bacteriologically. Rheumatic fever is rare; Herringham only saw five cases in France between October, 1914, and October, 1915, though it subsequently became rather more common, and I only saw a single definite case in Salonica; in the few cases so diagnosed, in which the pain is really localized in the joints, the arthritis is almost always gonococcal and not rheumatic. We are thus left with a number of cases of pyrexia of unknown origin; in this paper two varieties of a well-defined febrile disease are described which account for a considerable proportion of these cases.

In the early summer of 1915 Major J. H. P. Graham drew attention to a type of fever occurring in the British Army in France, in which two periods of pyrexia were separated by a normal interval. Similar cases were recognized with increasing frequency, and the disease soon became widely known as "trench fever." In November, 1915, Captain G. H. Hunt and Major A. C. Rankin described thirty cases of the same kind of trench fever, and a still fuller account was published in February, 1916, by Captain J. W. McNee, Lieutenant A. Renshaw and Captain E. H. Brunt, in which for the first time two distinct clinical types of the disease were distinguished.

The disease was only observed among officers and men living near the trenches and in the personnel of hospitals, especially among orderlies of wards in which there were patients suffering from the disease. No cases occurred among ammunition columns, ordnance and headquarters troops. It was for this reason that the name trench fever was adopted, though actual residence in the trenches themselves was certainly not an essential factor, and Hunt and McNee in their most recent communication state that cases have recently been met with further from the front.

According to Colonel Sir Wilmot Herringham, literally thousands of cases of the first type occurred among the troops in France and Flanders between the end of April and October, 1915; it was comparatively rare in the following winter, but increased again in the spring of 1916. It did not occur in Gallipoli and was not definitely recognized in Salonica until April, 1916. The second type, which was rare in France and Flanders until November, 1915, when it became more common than the first, has been very prevalent in Salonica since December, 1915. At first cases had to be recorded as "P.U.O." (pyrexia of unknown origin), or under the head of influenza, or some other equally incorrect name, even when their nature had been recognized. For this reason it became customary to call the disease "pyrexia of unknown origin (A)," or shortly P.U.O. (A), as this designation did not introduce into the official records an unauthorized name, such as "periodic one-day fever" or "Salonica fever," which had been used by some medical officers. The term trench fever was not used, as besides being an unauthorized name the disease was common in Salonica at a time when no men were living in the trenches, and cases occurred in ammunition columns several miles from the trenches as well as in front line troops and in hospital attendants. When, however, in March, 1916, I recognized that the disease was identical with the long form of trench fever described by McNee, Renshaw and Brunt, and when a month later, the common short form of trench fever seen in France and Flanders became prevalent in Salonica, it seemed wise to adopt this name.

A few cases with symptoms intermediate between the two types of trench fever have been observed in France and in Salonica, and the initial symptoms are very similar, but the temperature chart is so different in typical cases and the second class occurred in such large numbers without the first in the winter months, although it was very rare in comparison with the first during the summer of 1915 in France, that it cannot yet be regarded as definitely

proved that the two diseases are really due to the same infection, as is generally believed by British observers in France.

My attention was first drawn to the disease in Salonica at the beginning of January, 1916, by Lieutenant Colonel McGavin, Major Wylie and Major Acland of No. 1 New Zealand Stationary Hospital. At first it was not widely recognized, but as medical officers became more familiar with its characteristics, it became clear that it was extremely common, especially in certain units.

With the exception of one man, who contracted the disease whilst in hospital from another case, all of the cases observed in Salonica up to March, 1916, belonged to men who had been several months in France, having come to Salonica from Marseilles in November and December, 1915. None had been in Gallipoli or Serbia. The short form of trench fever had occurred in several of the affected units whilst they were in France. They went to France from India at the end of 1914, and included many old soldiers, a large proportion of whom had had malaria. It is highly probable that these men brought the infection with them from France. In March, 1916, the long form of trench fever began to occur in a division which had been in Serbia, but not in France; some of the men had been in Gallipoli, but most had come straight to Salonica from England. In April, groups of cases of both forms of trench fever appeared in units belonging to other divisions, which had been free from the disease since their arrival at the end of 1915. The later cases probably became infected by men coming in drafts from France. The disease also developed among the personnel of some of the hospitals to which the patients were sent.

Early in 1916, Schrotter described in a Vienna journal cases of the first variety, which he had observed in Austrian troops in the Tyrol, and Werner, in a Munich journal, cases of the second variety, which he had observed in a German field hospital on the eastern front.

Pathology.—Before trench fever could be accepted as a clinical entity it was necessary to prove that it was not an aberrant form of some other condition, such as paratyphoid fever, which it may closely simulate during the first pyrexial period, true relapsing fever, which it resembles in so far as the fever is of a characteristic relapsing type, and malaria, which is sometimes simulated by the shorter and sharper pyrexial attacks. But the blood taken at the height of both the initial and the latter febrile periods has always been sterile on cultivation, the Widal reaction has been consistently negative at every stage of the illness, and no spirochæte nor

malarial plasmodium has been found in spite of repeated examinations of blood films taken both during febrile and afebrile periods.

McNee and Renshaw found that trench fever could be transmitted to healthy soldiers by the intramuscular or intravenous injection of the blood of men suffering from the disease. Injection of the washed red corpuscles had the same effect, but the plasma and serum were not infective.

One attack does not seem to protect against re-infection. I saw a man with the long type of trench fever in April, 1916, in Salonica; he had been seen by Captain McNee in a typical attack in September, 1915, while in France, and had been quite well in the interval. It is possible, however, that there was no re-infection, the original infection having remained latent between the two attacks.

As all attempts to discover the infective organisms have failed, and as no fatal case has occurred, the nature of the disease remains unknown. The striking periodic character of the fever in the long type of case, the considerable increase in the proportion of large mononuclear leucocytes, which has been found on several occasions, and the evidence pointing to an intracorpuscular infection suggest a protozoal rather than a bacterial origin.

Method of Propagation.—There is no nasal-pharyngeal or bronchial catarrh and, except for constipation, gastro-intestinal symptoms, though occasionally well marked, are generally completely absent. It is probable, therefore, that the disease is not conveyed by the respiratory secreta or by the fæces, but through the intermediation of some insect. The occurrence of the long form of the disease during the winter months shows that the infection can be conveyed in the absence of mosquitoes and other flying insects; though Herringham found mosquitoes in France throughout the winter, there were certainly none in Salonica. Fleas have been scarce in both countries and the men themselves rarely complain of them. Almost all patients admitted that they were lice-infested up to the time of their entry into hospital, so that it is quite possible that the disease is conveyed by lice. A hospital orderly, who had been free from lice since his arrival in Salonica, had to carry the kit of a number of new patients suffering from trench fever on May 2, 1916. The clothes were swarming with lice and the same evening he found some in his own clothes. He got rid of them in the course of a few days, and on May 20 an attack of trench fever began. He was not employed in the wards

and he never came in contact with any patient suffering from the disease. He was the first case of trench fever in the personnel of the hospital to which he was attached. The incidence of trench fever is least in the cleanest battalions and in the divisions which have the best facilities for bathing. In some units a successful campaign against lice has been immediately followed by a great diminution in the incidence of trench fever. Captain Urquhart developed the short form of trench fever after allowing the lice from a patient with this form of the disease to bite him, and Captain McNee tells me that his observations in France have led him to agree with the conclusion I came to in Salonica—that the disease is spread by lice.

Cold, wet, and fatigue appear to be exciting causes in a man who has become infected, but has so far had no symptoms; thus Captain Hay noticed that almost all cases in his regiment in Salonica began two or three days after they had been wet through. In several instances a group of men sleeping in the same tent have been affected.

Some patients appear to be carriers, who do not lose the infection completely for several months, but have recurrences from time to time, during each of which they may infect an additional number of men. A serjeant, who had been in good health whilst in France between December, 1914, and November, 1915, developed the long form of trench fever early in December, 1915, directly after he left France for Salonica; in the following four months he was in hospital five times for a week or more, though he was perfectly well in the intervals. Every time he returned to his unit he became lice-infested again, and appeared to infect some of the men with whom he came in contact, about forty men of his company, including six serjeants, having been taken ill with trench fever between January and March; one of the serjeants had wrestled with him, another had danced with him, a corporal slept next to him, and a private sat next to him for some lectures.

Incubation Period.—As a result of observations in Salonica on cases arising in hospital when a patient had been admitted for some other condition, I came to the conclusion that the incubation period is between fifteen and twenty-five days; in the case of the hospital orderly already described it was probably eighteen days. Quite independently Hunt and McNee in France concluded that it was between fourteen and twenty-four days. The following three cases are typical of those which led to my estimate of the incubation period. (1) Serjt. B., R.E., was admitted for rhinitis on

December 27, 1915, into a ward in which there were at the time two patients suffering from the long form of trench fever, no other cases of which have yet been observed in his unit. On January 1, 1916, he was moved into another ward, in which there were, and have since been, no such cases. When convalescent from the rhinitis, which had been accompanied by no pyrexia or pains in the head, back or legs, he suddenly became ill on the evening of January 24; his temperature in the morning was normal, but at 6 p.m. it was 104° F. This proved to be the first pyrexial period of a typical attack of the long form of trench fever. It was probable that the infection was contracted from the other cases in the ward between December 27 and January 1, between twenty-three and twenty-seven days before the onset of symptoms.

(2) Pte. W. went to France at the beginning of the War with the 1st —— Regiment. He was wounded in January, 1915, and was in England until the end of 1915, when he came to Salonica, joining the 2nd —— Regiment, which had come there from France in November or January 13, 1916. A few days after he arrived he became lice-infested. On January 21 he went to a field ambulance, and then to a casualty clearing station with a hydrocele; he was transferred to a stationary hospital on February 6. On February 12 his temperature rose, and a typical attack of the long form of trench fever began. His clothes were disinfected when he entered the casualty clearing station, and he had no more trouble with lice after his admission there. It is probable that he contracted the disease whilst with his regiment, i.e., between twenty-four and sixteen days before the onset; as he was not lice-infested until he had been with his regiment some days, the period was probably about twenty days.

(3) A third patient was admitted into hospital for quinsy. He was in a ward in which there were no other cases of trench fever, but developed the disease fourteen days after admission, He had probably contracted it whilst still with his regiment, in which at least one case had already occurred, so that the incubation period was over a fortnight.

Symptoms.—The disease generally begins suddenly without any premonitory symptoms, but a feeling of malaise occasionally precedes the attack for a day or two. The patient complains of severe headache, especially frontal and behind the eyes, and this is rapidly followed by pain in the lower part of the back and on the second or third day in the legs. Pain in the neck is occasionally observed; in two cases mentioned by Hunt and McNee pain and

stiffness in this region was so severe that a lumbar puncture was performed in order to exclude meningitis, and I also saw two cases in Salonica in which this was done. The patient generally shivers, but there is never a definite rigor; he is occasionally flushed, and often sweats profusely. The bowels are regular or constipated, and there is no nasal or bronchial catarrh; the appetite is lost, the tongue is moist, and often slightly furred, and occasionally mild pharyngitis is present. Herpes labialis has occurred in a few cases, but less frequently in the long than in the short form of the disease. There is no rash.

The onset is sometimes extremely abrupt; the patient suddenly feels giddy with a burning head, he shivers and may be very short of breath, and complains of a pain in his left side. He has to fall out if on parade or marching, and has often great difficulty in returning to camp without assistance.

In a few cases, in which constipation is generally present there is some abdominal pain with slight distension and tenderness, and there may be nausea and some vomiting at the onset. Four out of my first fifty cases of the long type were sent to hospital diagnosed as appendicitis; in one a normal appendix was removed, and a second would have been operated upon had he not refused. The abdominal symptoms rapidly disappeared and in the relapses they were less prominent than the other symptoms.

When the pain in the legs is severe, there may be some cutaneous hyperæsthesia over the shins. In several cases the periosteum of the tibia has seemed to me to be rough and thickened, as it pits slightly on pressure, although no pitting of the subcutaneous tissue was present. The tenderness is most marked over the lower half of the shins and may be very severe, a comparatively slight pressure causing the patient to cry out, and the pain produced may last for hours. A less degree of tenderness is often present in the tendons behind the knee, and occasionally in the ligamentum patellæ and along the course of the femur. The shins are always tender, even if the patient complains of no pain in the legs, but tenderness appears most marked in groups of cases and at certain times. Graham did not mention it, and it was not observed in the earliest cases in Salonica. There is little or no tenderness of the calves or other muscles. The knee and ankle jerks are normal.

In the first attack the spleen is sometimes palpable or is found to be enlarged on percussion, and there may be some tenderness in the left hypochondrium. Although this was certainly the case in

Salonica, Herringham and Hunt and McNee never found any splenic enlargement in the cases they observed in France.

Leucocytosis is often, but not always, present during the pyrexial attacks; the count varied between 4,700 and 22,000 per cubic millimetre in 35 cases, mostly of the short type, examined in France (Hunt and Rankin, McNee, Renshaw and Brunt); in many of the cases examined both in France and in Salonica there was a relative increase in the large mononuclear cells (Elworthy, Urquhart). Polychromatophil cells above the normal size with well-marked punctate basophilia were observed by McNee, Renshaw and Brunt in France, but Elworthy, working in Salonica, came to the conclusion that they only occurred in the later stages of the more severe cases. The percentage of hæmoglobin is generally about eighty, though the number of red corpuscles is undiminished.

In the *short form of trench fever* the temperature rises rapidly to between 102° F. and 104° F., but the pulse rate is only slightly increased. On the third or fourth day the temperature suddenly falls—generally to normal or subnormal, but there is no corresponding improvement in the symptoms. After an interval of a few hours it rises again and then after another two to five days it falls to normal; on this occasion there is immediate relief to all of the symptoms. In some cases the remission on the third or fourth day does not occur, the temperature remaining raised for about a week. There is often a single relapse after an interval varying from a few hours to ten days, but generally less than four days; the temperature rises to 100° F. or 101° F. for twenty-four or forty-eight hours, during which the symptoms return with diminished severity. The patient is generally fit for duty almost immediately after the temperature falls again. Many cases have subsequently been kept under observation by Hunt and McNee for weeks or months without any return of fever or other symptoms, so that there could be no question of additional relapses occurring after the patient had been discharged from hospital.

In the *long or periodic type of trench fever* the temperature rises to between 101° F. and 104° F. on the first evening. The initial attack is variable in duration; the temperature may be normal the first morning, high in the evening, normal the second morning, and rather less high the second evening than the first, after which it remains down. In other cases the first attack may last as long as four or five days, the temperature being always lower in the morning than the preceding and following evening, the highest temperature being reached on the second or

third day; in one case it reached 105·8° F. on the third evening, though it was normal the previous and following mornings. The pulse is generally accelerated in proportion with the temperature, but at first it may be considerably faster. With the fall of temperature at the end of the initial attack all the symptoms disappear and the patient is often sent back to duty.

After being well for two to ten days he complains of a return of headache and pain in the legs, which culminate at night; the temperature rises in the evening to a point which is generally a little lower than the highest temperature in the first attack. The temperature falls to normal or nearly normal the next morning, and either remains down or rises to a less extent the second evening, thereafter to remain normal. The general symptoms are much less severe than in the first attack and the acceleration of the pulse is less marked, but the pain in the legs and tenderness of the shins are generally greater, and they may not disappear completely in the interval between the second and third attacks, though the headache, which generally remains the most prominent symptom during the attack, is never present in the apyrexial periods. The pain in the legs is sometimes extreme and may prevent sleep; in other cases it is comparatively slight and the patient looks and feels remarkably well, considering that he has a temperature of 101° F. or more.

Recurrences follow periodically, the maximum temperature being always reached in the evening. The intervals between the height of the attacks is fairly constant in each case, but it varies in different cases between four and eight days, five being the most common interval. Each succeeding attack is generally milder than its predecessor and the temperature is rather lower, but in severe cases the patient feels weaker in the later intervals, and the pain and tenderness of the legs are more persistent. The later attacks may be of such short duration that the rise in temperature is not recorded at all if it is only taken twice a day. On the afternoon and evening of the day on which the attack is expected the temperature should therefore be taken every two hours, especially if there is any pain in the head or legs, as in most cases the patient knows from his sensations there is going to be a relapse, even before the temperature rises. The temperature is sometimes only raised for three or four hours: in one case, for example, the morning temperature was 98° F., at 5.30 p.m. it was 99° F., 6.30 p.m. 100° F., 8 p.m. 101° F., and at both 9 and 10 p.m. and at 8 a.m. the following morning

98·4° F. In another case it was 97·6° F. at 5 p.m., though the patient had had a headache since the morning, but 101·4° F. at 8 p.m., 102·4° at 10 p.m., 101·4° at 2 a.m., 100·2° F. at 6 a.m. and 98° F. at 8 a.m., so the chart showed no rise, as the temperature in the ward was taken at 8 a.m. and 5 p.m. This liability to miss the rise in temperature accounts for the fact that it may appear from the chart that an attack has been missed, the interval between two of the later attacks being double that between the earlier ones; a headache may have been felt and a rise in the pulse rate recorded half way between the attack. In some cases the temperature is subnormal between the last two attacks, in which it rises to normal but no higher.

In a few cases the temperature remains raised for three or even four days in each attack, the evening temperature being always higher than the morning temperature, which may be normal on the first and last days; the highest point is generally reached the second evening.

Diagnosis.—The diagnosis can only be made with certainty from a study of the temperature chart, but the association of pyrexia with tender shins is very suggestive of trench fever already in the first attack. Painful and tender shins have, however, sometimes been observed in the Salonica Army in the absence of fever and the unsatisfactory name of "trench shin" has sometimes been used to describe such cases. Some of the cases regarded as examples of the short form of trench fever are probably really periodic cases, as there is no doubt that the later bouts of pyrexia are often entirely missed owing to the short time they last, the patient having meanwhile gone back to duty, or if in hospital the evening temperature may have been taken at 5 p.m., although the rise only began at 7 p.m., or later. Several medical officers, who were very familiar with the early stages of the disease, only recognized the periodic rise of temperature after their attention had been specially drawn to its occurrence, as their patients had returned to duty after the first or second attack, and had not "gone sick" for the later and comparatively slight recurrences.

The majority of cases were at first diagnosed as *influenza*, though it was generally recognized by medical officers that they were not identical with the familiar forms of influenza. Thus there is never any nasal or bronchial catarrh, the patient rarely appears or feels seriously ill, except sometimes during the first two days of the first attack, and cardiac, respiratory and nervous complications never occur. The periodic return of pain and pyrexia and

pain and tenderness of the shins are quite characteristic and prevent confusion with influenza except at the onset.

The possibility of *malaria* must always be considered, and a blood film should be examined for the malarial plasmodium before making a definite diagnosis in cases of doubt, especially when malaria is prevalent or if the patient has previously had malaria. The differential leucocyte count is of no assistance, as there is a relative increase in large mononuclear cells in both diseases. The longer intervals between the attacks, their invariable occurrence in the evening instead of at various times of the day, the absence of true rigors and the failure of quinine to modify the course of the illness are distinguishing features of trench fever. Several old soldiers at first thought that they were suffering from malaria, but they subsequently realized that the disease must be different, as they never before had had severe pain and tenderness in their shins.

A few cases of true *relapsing fever* occurred in British as well as Indian troops at Gallipoli, but only eight Indian and no British soldiers had been attacked by the disease in Salonica up to the end of April. The disease was, however, common in the Serbian Army in 1915, and was actually first described by Hippocrates in the Greek Island of Thasos, so it is necessary to be on the look out for it among British as well as Indian soldiers at Salonica, and at least one case occurred in June, 1916. In six cases I saw with Captain Struthers Smith, I.M.S., the pyrexial period was generally longer, varying between two and a half and six days, and the fever was higher than in trench fever, the maximum temperature in each attack being between 104° F. and 105·6° F., successive relapses did not diminish in severity unless they were cut short by injecting salvarsan, the effect of which was almost instantaneous ; the patients were extremely ill and often delirious during the pyrexial periods, and the delirium occasionally continued after the temperature fell ; bronchitis was common, and there was no pain in the legs nor tenderness of the shins ; the apyrexial periods varied between two and eight days, six days being the most common, but the periodicity was less regular than in the periodic type of trench fever. The spirochæte was found without difficulty in the blood during the pyrexial period in every case. The disease may, however, be less severe when it occurs among Europeans.

Prognosis.—There have been no fatal cases, and the patient never appears seriously ill, except occasionally for a very short time in the first attack.

Until the commencement of the hot weather in Salonica at the end of May, no complications had been observed with the exception of phlebitis of the femoral vein in one case, and slight jaundice in two cases, but the latter at any rate was probably accidental. With the onset of the hot weather it was found that trench fever was often accompanied by a moderate degree of cardiac dilatation, which resulted in the development of "soldier's heart" if the patient returned to full duty too soon. Endocarditis has never occurred. Hunt and McNee have not observed albuminuria, but Herringham found a trace of albumin which soon disappeared in a few cases. I know of no case in which albuminuria occurred in Salonica.

The total duration of the periodic type of trench fever from the onset to the end of the last attack is generally between four and six weeks, but some cases appear to abort and in a few others attacks may recur for several months, the patient remaining quite well in the intervals. I saw a serjeant with the periodic form of trench fever in January, 1916, in Salonica; he had had similar attacks at intervals since August, 1915, when he first became ill in France. In most cases the patient rapidly gets strong again after an attack, and is generally fit for duty after the second period of pyrexia, though he may have to rest for a few hours when the later attacks occur. Sometimes, however, great exhaustion follows and convalescence is slow.

Prophylaxis.—As the disease is probably conveyed by lice, which become infected by biting a patient during an attack, every effort should be made to keep troops free from them. All cases of trench fever should either be sent to hospital or isolated, and the patient's clothes and bedding should be specially disinfected as well as that of all men who have recently slept near him. After the initial or the second attack a man is often able to return to duty; it is very important that he should be kept under observation, and if he again becomes verminous his clothes and bedding should again be disinfected; men who are still having attacks or have recently recovered should sleep together isolated from the other men in their unit, but there is no reason why they should not work with them.

Treatment.—No treatment has yet been found which prevents the periodic return of attacks or which is really effective in overcoming the pain. It is generally agreed that in the first attack considerable relief occurs if the tendency to constipation is prevented by aperients. Acetyl-salicylic acid is the most effective

analgesic drug. Quinine has been repeatedly tried without success, both by mouth and subcutaneous injection, and salvarsan and antimony have proved useless. In one severe case Hunt and McNee tried intravenous injections of eusol without success, and in two others twenty cubic centimetres of the serum of a convalescent patient was injected intravenously without influencing the course of the illness.

Numerous local applications, both hot and cold, have been used for the painful shins; some of them have appeared to do good in certain cases, but the most frequently successful seems to have been a cold compress of saturated magnesium sulphate solution, which was first recommended by Captain D. S. Harvey. In slight cases gentle massage has given temporary relief. In a few cases in Salonica the periosteum was incised, but when this was done on one side only, improvement occurred with equal rapidity on the opposite side. Even if the results had been more promising I should regard the operation as quite unjustifiable, as the pain always disappears spontaneously in the course of a few weeks and often quite rapidly even when it is exceptionally severe.

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THE SURGICAL ANATOMY OF THE SYNOVIAL MEMBRANE OF THE KNEE-JOINT.

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One of the most anxious of the various problems that present themselves for the consideration of the surgeon dealing with wounds in war is that of injuries involving the knee-joint. An apparently trivial penetrating wound may result in a stiff joint, amputation of the limb, or even death, notwithstanding great care, and in some cases, vigorous and radical treatment.

A movable joint after an infected wound of the knee is something to be proud of. The reason for this is not far to seek. The knee-joint has the largest and most complex synovial membrane in the body. Its size is not a matter of much consequence, except that a large surface is exposed for absorption of bacterial poisons, should infection occur. It is the complexity of the joint that renders treatment so difficult. Diverticula, folds, recesses, and communications with bursæ, render it impossible thoroughly to drain; and irrigation, unless perhaps by a powerful force pump, is quite inadequate to reach and wash out the various culs-de-sac connected with the main cavity.

The question of foreign bodies in the joint is another problem. Their exact location and the best methods of approach require skilled X-ray work, and a knowledge of applied anatomy. Since I have been with the forces in France I have found good stereoscopic X-ray pictures, studied in conjunction with drawings from sections hardened in formalin kindly made for me by Professor Symington, of Belfast, of inestimable value. I have added to these an X-ray photograph kindly supplied by Lieutenant-Colonel Robert Jones, of Liverpool, showing a joint inflated with oxygen, and also photographs showing joints injected with bismuth. The object of this paper is to illustrate the more important details of the synovial membrane from a surgical point of view, and to supply the shortest possible description compatible with clearness.

The articulation is composed of three parts, two femoro-tibial and a femoro-patellar (figs. 8 and 9). In some animals there are three separate synovial membranes. The arrangement in the

human subject indicates its composite nature. The cruciate ligaments are the lateral ligaments of the femoro-tibial joints (fig. 8). Thus the external condyle is held in its position on the superior articular surface of the tibia by the external lateral ligaments (fibular collateral) externally, and the anterior cruciate ligament, which represents an internal lateral ligament, internally. Similarly, the

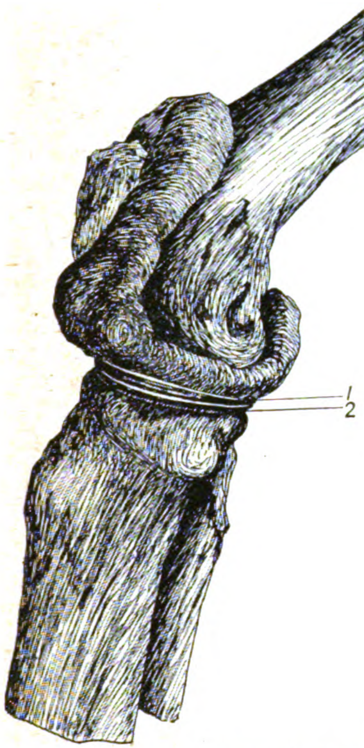

FIG. 1. — Internal view of right knee-joint, showing distended synovial membrane. (1) Internal semilunar cartilage; (2) synovial membrane below cartilage.

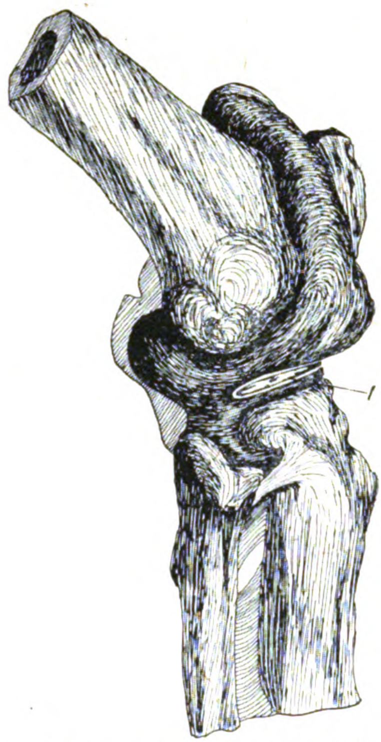

FIG. 2. — External view of right knee-joint, showing distended synovial membrane. (In this case the cavity communicates with the superior tibio-fibular articulation. (1) External semilunar cartilage.

internal condyle is held in position by the internal lateral ligament (tibial collateral) internally, and the posterior cruciate ligament which represents an external lateral ligament, externally. The cruciate ligaments which cross each other like the letter X divide the intercondylar fossa into two lateral recesses, into which, as we shall see, pockets of synovial membrane extend (figs. 6 and 8). The

infra-patellar pad of fat (figs. 7, 8 and 9) further tends to sub-divide the joint into its component parts. It consists of a wedge-shaped central portion (fig. 9) which extends backwards and upwards to the intercondyloid fossa and two lateral wings which extend along the lateral borders of the lower part of the patella. Covered by synovial membrane, the central portion is attached above (proximally) to the anterior margin of the intercondyloid fossa. It is known as the ligamentum mucosum (patellar synovial fold) (figs. 7 and 15). The lateral extensions similarly invested by synovial membrane, form

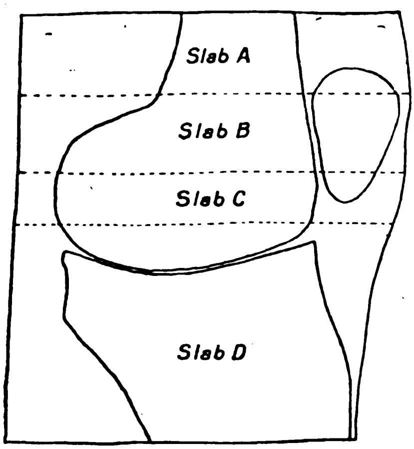

FIG. 3. — Key figure showing sagittal section of left knee through the inner condyle of femur.

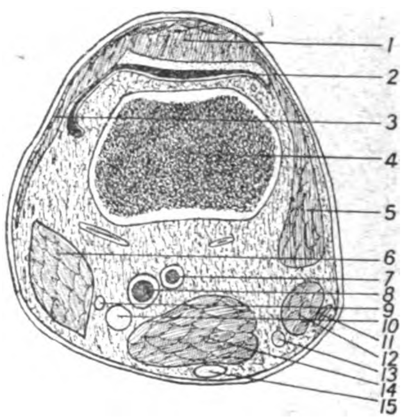

FIG. 4. — Horizontal section through knee-joint, dividing femur but passing above patella, viewed from above (*see* fig. 3, *Slab A*.) (1) Quadriceps muscle; (2) joint cavity; (3) fascia lata; (4) femur; (5) vastus internus; (6) biceps muscle; (7) popliteal artery; (8) popliteal vein; (9) common peroneal nerve; (10) tibial nerve; (11) great saphenous vein; (12) sartorious muscle; (13) gracilis muscle; (14) semimembranosus muscle; (15) semitendinosus muscle.

the ligamenta alaria (plicæ alares). These ligaments (more properly called folds) form a pad which fills up the irregular space between the patella, femoral condyles and tibia (fig. 7).

The semilunar cartilages (menisci) are shown in figs. 7 and 8, and their wedge-shaped appearance in section is well shown in figs. 10 and 11, in which the parts are represented as separated somewhat, to show how the synovial membrane invests the upper and under surfaces and free borders. It should be remembered that while the internal lateral ligament is adherent to the internal semilunar car-

tilage (medial meniscus) at its convex border, the external lateral ligaments are separated from the external semilunar cartilage (lateral meniscus) by the tendon of the popliteus (figs. 7, 8 and 11) which, covered by a pouch-like prolongation of synovial membrane is prolonged backwards and downwards and grooves the outer convex border of the meniscus. This cartilage has, therefore, a covering

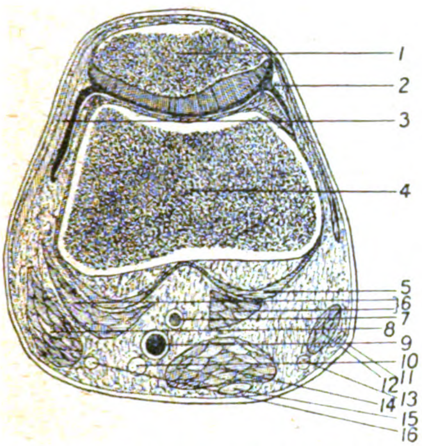

FIG. 5.—Horizontal section of knee-joint, dividing the femur and patella, viewed from above (see fig. 3, *Slab B*). (1) Patella; (2) joint cavity; (3) fascia lata; (4) femur; (5) oblique popliteal ligament; (6) gastrocnemius muscle; (7) popliteal artery; (8) biceps muscle; (9) popliteal vein; (10) tibial nerve; (11) great saphenous vein; (12) sartorious muscle; (13) gracilis muscle; (14) semimembranosus muscle; (15) semitendinosus muscle; (16) common peroneal nerve.

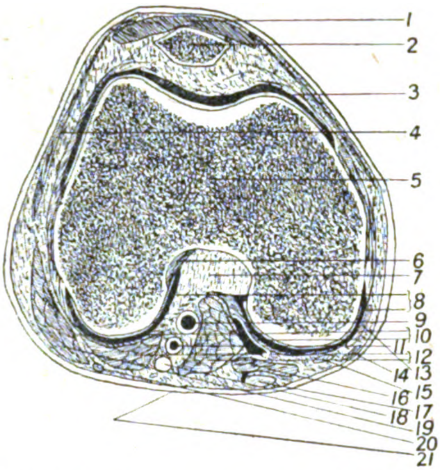

FIG. 6.—Horizontal section of knee-joint, dividing femur and the lower end of the patella, viewed from above (*see* fig. 3, *Slab C*). (1) Patellar ligament; (2) patella; (3) joint cavity; (4) fascia lata; (5) femur; (6) anterior cruciate ligament; (7) posterior cruciate ligament; (8) joint cavity; (9) popliteal artery; (10) oblique popliteal ligament; (11) popliteal vein; (12) gastrocnemius muscle; (13) sartorious muscle; (14) great saphenous vein; (15) gracilis muscle; (16) semimembranosus muscle; (17) semitendinosus muscle; (18) tibial nerve; (19) biceps muscle; (20) common peroneal nerve; (21) bursa under semimembranosus and gastrocnemius.

of synovial membrane on its outer convex border for part of its extent (figs. 7, 8 and 11. See also figs. 13 and 14). The capsule of the knee-joint, together with the ligaments, tendons and fascia which strengthen it, forms a complete investment for the joint, except at those places where communications with bursæ exist. It is very thin above the patella where it is represented merely by the layer of synovial membrane which invests the under surface of the quadriceps muscle and is reflected on to the femur (fig. 15).

Here pus distending the joint may break through and burrow in the fascial planes of the thigh. In this connexion the possibility of the presence of Baker's cysts, which are hernial protrusions of the synovial membrane through defects in the capsule, ought to be borne in mind. These might, of course, become pockets of pus in septic infection of the joint and complicate the treatment.

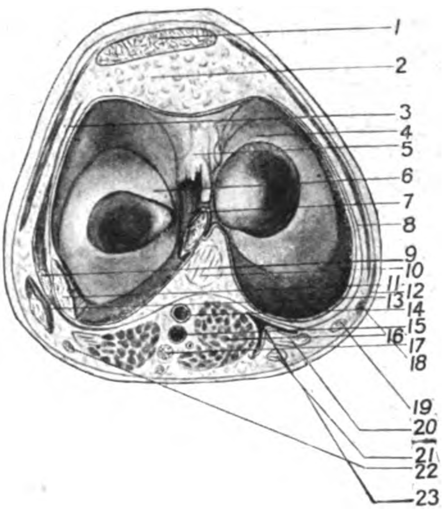

FIG. 7.—Horizontal section through knee-joint, dividing the condyles of femur and ligamentum patellæ, viewed from above (see fig. 3, *Slab D*). The lower end of femur was removed to show the synovial cavity, cruciate ligaments, and semilunar fibrocartilages. (1) Patellar ligament; (2) infrapatellar fat; (3) capsule of joint; (4) internal semilunar cartilage; (5) ligamentum mucosum; (6) external semilunar cartilage; (7) anterior cruciate ligament; (8) capsule of joint; (9) external lateral ligament? (10) posterior cruciate ligament; (11) popliteus muscle; (12) sartorious muscle; (13) biceps muscle; (14) popliteal artery; (15) popliteal vein; (16) gastrocnemius muscle; (17) tibial nerve; (18) great saphenous vein; (19) gracilis muscle; (20) semimembranosus muscle; (21) semitendinosus muscle; (22) common peroneal nerve; (23) bursa under semimembranosus and gastrocnemius.

The joint cavity is bounded by the articular cartilage and synovial membrane. The articular cartilage forms a firm, unyielding, non-vascular wall, whereas the synovial membrane, as a rule, is thin, readily displaced and vascular, except over the semilunar cartilages where it becomes very thin and firmly adherent. In addition to lining the capsular ligament it covers the non-articular portions of the bones within the joint (fig. 8) and various pads of fat.

The joint cavity not only extends between the articular ends of the bones, but into numerous extensions of the synovial membrane.

Thus a pouch is pushed up under the quadriceps and invests this muscle on its under surface and the femur for a distance of about an inch above the upper border of the patella (fig. 15. See also figs. 1, 2 and 9). In figs. 13 and 14 the joint has been over distended with bismuth emulsion to show the arrangement of the cavity and its diverticula. In fig. 9 its vertical extent is less than normal.

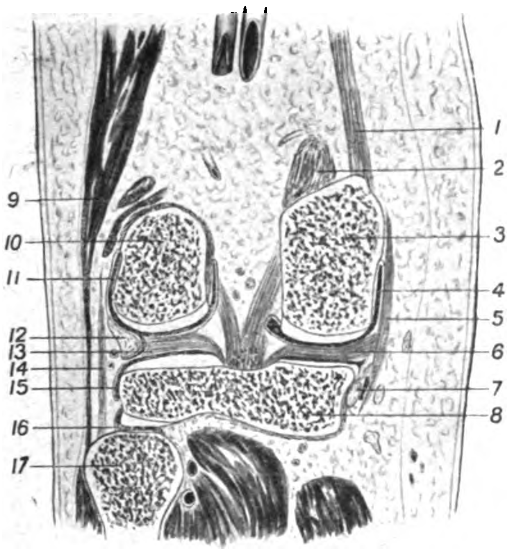

FIG. 8.—Transverse vertical section through left knee and tibiofibular joints, viewed from behind. The femur was divided through the posterior part of its condyles, and the cruciate ligaments cut in the intercondyloid fossa. (1) Adductor magnus ; (2) inner head of gastrocnemius muscle : (3) inner condyle ; (4) synovial cavity ; (5) internal lateral ligament ; (6) internal semilunar cartilage ; (7) semimembranosus muscle ; (8) tibia ; (9) biceps muscle ; (10) external condyle ; (11) synovial cavity ; (12) popliteus tendon ; (13) external semilunar cartilage ; (14) external lateral ligament ; (15) synovial cavity : (16) superior tibiofibular joint ; (17) head of fibula.

This is due to the hardening process in the specimen from which the drawing was made. This protrusion communicates with a bursa which extends for about another inch by an opening which may be quite small, but is generally so large that the sacs are practically continuous, as shown in figs. 13 and 14. The lateral extent of this upward protrusion is represented in figs. 4, 5 and 6, from slabs cut at the levels shown in the key (fig. 3 ; see also figs. 1, 2, 13 and 14). It will be apparent that a penetrating wound

involving the anterior third of the circumference of the thigh within two inches of the upper margin of the patella or the condylar surface of the femur is almost certain to be a wound of the joint, except in those rare cases in which the suprapatellar bursa does not communicate with the cul-de-sac from the joint. We have lately dissected a joint in which the suprapatellar bursa was filled with pus, but did not communicate with the joint. It is important to remember that occasionally the opening between these two cavities is quite small and that movement may pump infective matter from one to the other, an accident which might

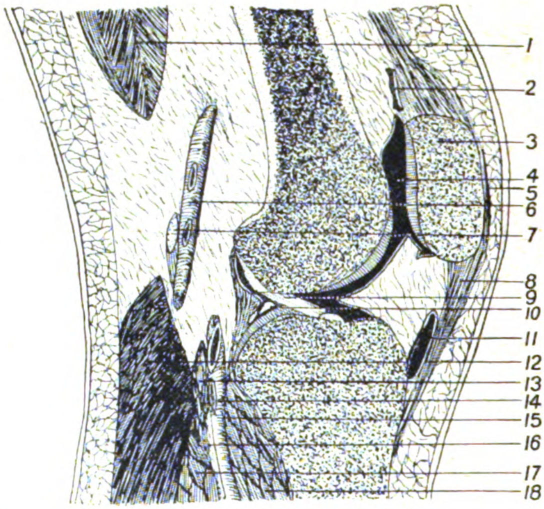

FIG. 9.—Vertical anteroposterior section, approximately through middle of knee-joint, lateral view. (1) Semimembranosus muscle; (2) suprapatellar bursa; (3) patella; (4) joint cavity; (5) prepatellar bursa; (6) popliteal vein; (7) peroneal nerve; (8) patellar ligament; (9) anterior cruciate ligament; (10) posterior cruciate ligament; (11) bursa over tubercle of tibia; (12) gastrocnemius muscle; (13) plantaris muscle; (14, 15) popliteal vessels; (16) tibial nerve; (17) soleus muscle; (18) popliteus muscle.

have been avoided by immobilization on a splint. In the kneeling position the cul-de-sac is drawn down with the patella and may thus escape injury. The synovial membrane which extends from the margin of the articular surface of the patella (fig. 15), is continued on to the infrapatellar fat forming the ligamentum mucosum and the ligamenta alaria, as before described (figs. 7 and 9). Note the arrangement in figs. 1, 2, 13 and 14, in which the joint has been distended. In the non-distended or normal state it will be seen that a missile can traverse the infrapatellar

region, and even project a considerable distance backwards towards the joint without actually involving the latter (fig. 9). It is important to remember that there is a bursa between the ligamentum patellæ and the tubercle of the tibia which must not be mistaken for the joint itself. In fig. 9 I have made an addition to the original drawing, showing the position of the bursa. A knowledge of the anatomy of this angle may enable a careful operator to remove a missile lodged there without opening into the knee-joint. In the distended joint (figs. 1, 2 and 14) the relations of the

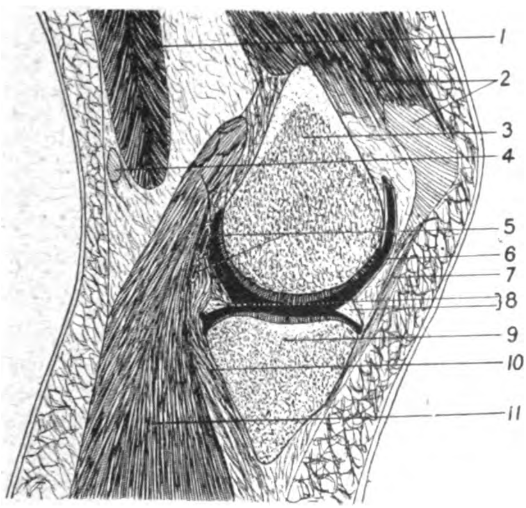

Fig. 10.—Vertical antero-posterior section of *right* knee internal to and 1·8 centimetres from section fig. 9, lateral view. (1) Semimembranosus muscle; (2) quadriceps muscle; (3) inner condyle of femur; (4) tendon of semitendinosus muscle; (5) bursa under gastrocnemius: (6) cavity of joint; (7) patellar ligament; (8) internal semilunar cartilage; (9) tibia; (10) insertion of semimembranosus muscle; (11) inner head of gastrocnemius muscle.

structures in this angle are much altered. The synovial membrane is reflected on to the condyles of the femur and the tuberosities of the tibia as far as the articular cartilage, and is then, as it were, pushed into the intercondyloid fossa, lining it and its contained fat and partially investing the cruciate ligaments (figs. 7, 8 and 9). In this way two recesses are formed, one on either side of the cruciate ligaments as they pass up from the non-articular surface between the facets on the upper (proximal) surface of the tibia to the intercondyloid fossa. These recesses are partially shown in figs. 6, 7, 8 and 9. The cruciate ligaments form a septum dividing the

synovial pouch in the intercondyloid notch into two cavities in either of which a foreign body may lodge (fig. 8). Pus is also likely to accumulate here, and in bad septic cases can only be efficiently dealt with by acute flexion after division of the lateral and cruciate ligaments and removal of the semilunar cartilages, or by excision of the joint. The posterior cruciate ligament (figs. 6 and 7) is devoid of synovial membrane at its posterior aspect where it is connected with the posterior ligament of the knee-joint. Missiles may be lodged in this cruciate ligament and

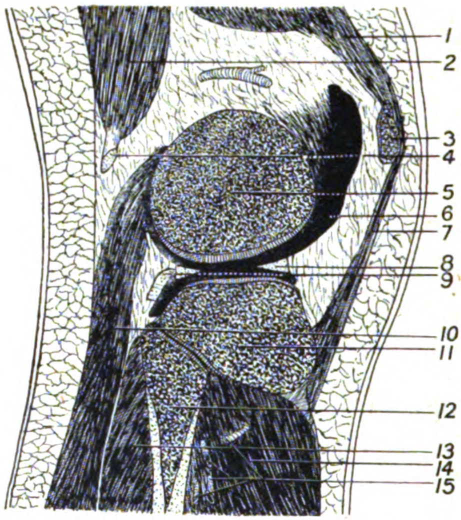

FIG. 11.—Vertical anteroposterior section of *right* knee, external to and 1·8 centimetres from section fig. 9. Lateral view. (1) Quadriceps muscle; (2) biceps muscle; (3) patella; (4) peroneal nerve; (5) femur; (6) joint cavity; (7) patellar ligament; (8) external semilunar cartilage; (9) tendon of popliteus; (10) gastrocnemius muscle; (11) tibia; (12) fibula; (13) soleus muscle; (14) tibialis anticus muscle; (15) anterior tibial vessels.

yet be entirely outside the joint and capable of being reached by an incision on the inner side of the popliteal vessels (figs. 6 and 7) always remembering the presence of the bursa in that situation which frequently communicates with the joint. The synovial pouches which invest the condyles of the femur are well shown in cross section in fig. 6, and in vertical section in figs. 8, 10 and 11.

Referring to fig. 6 it will be seen that at this level there appear to be three pouches—two condylar and one behind the patella. Compare this fig. with figs. 1 and 2, in which the synovial

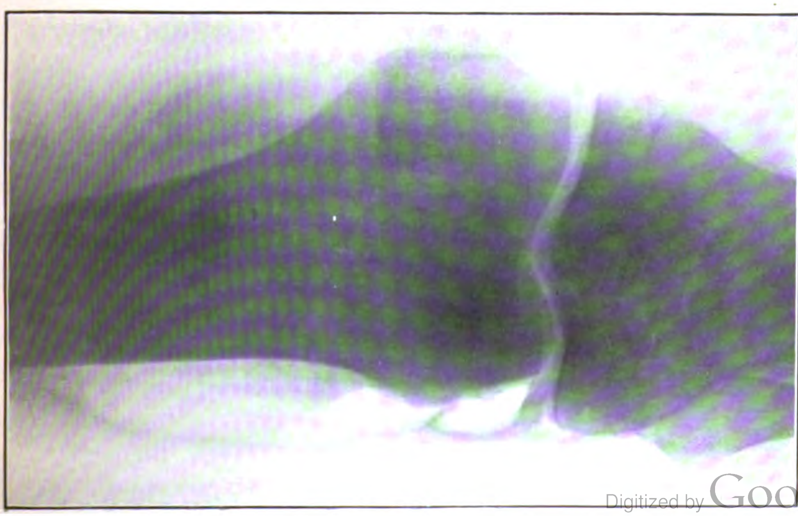

FIG. 12.—Joint injected with oxygen, antero-posterior view.

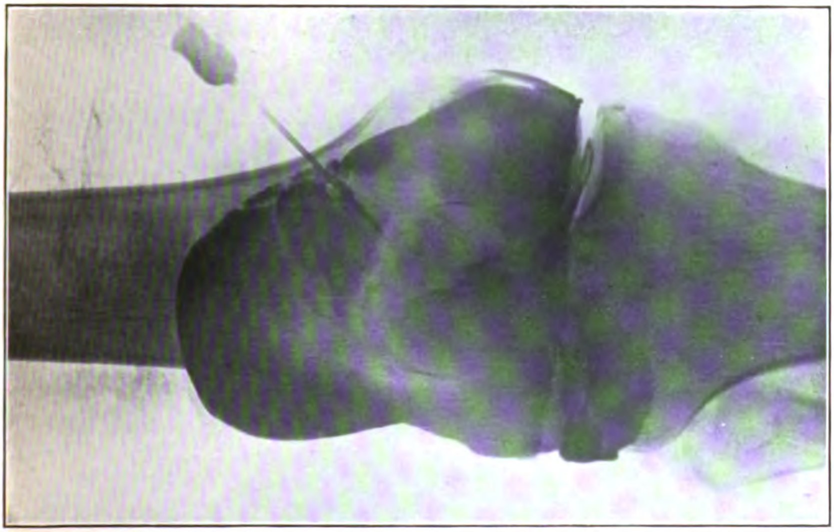

FIG. 13.—Joint injected with bismuth, antero-posterior view.

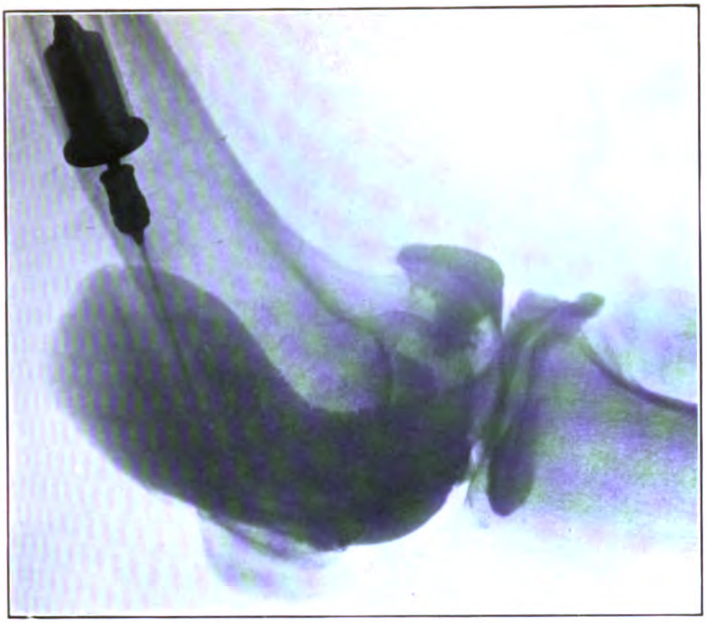

FIG. 14.—Joint injected by bismuth, lateral view. Note extension along popliteus tendon.

To illustrate "The Surgical Anatomy of the Synovial Membrane of the Knee-Joint." By Temp.-Colonel ANDREW FULLERTON, M.D., M.CH., F.R.C.S.I.

membrane has been distended, for an explanation of the appearances seen. The synovial pouch is prolonged up behind each condyle to invest the cartilaginous surfaces, the whole sac as seen laterally resembling the letter "J." The synovial membrane is reflected from the cartilaginous surfaces of the tibia to invest the semilunar cartilages as shown in figs. 10 and 11. In fig. 12 the joint has been distended with oxygen and the potential pockets, especially those between the cartilages and the tibia, are well

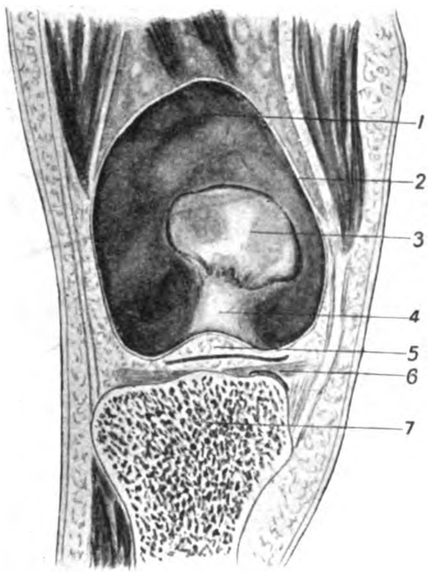

Fig. 15.—Transverse vertical section of knee-joint, viewed from behind. The femur has been removed to show the anterior portion of the cavity of the knee-joint with articular surface of patella. (1) Suprapatellar pouch; (2) cut edge of synovial membrane; (3) patella; (4) ligamentum mucosum; (5) infrapatellar pad; (6) internal semilunar cartilage; (7) tibia.

shown. Compare also figs. 13 and 14. On the outer side, the tendon of the popliteus muscle (figs. 7, 8 and 11) receives a finger-shaped diverticulum of synovial membrane which partially invests it and generally accompanies it as far as the tibio-fibular articulation, occasionally communicating with the latter (fig. 2). This process of synovial membrane separates the tendon from the posterior part of the external surface of the external semilunar cartilage and from the tibia (see figs. 8, 11 and 14). It is a source

of serious danger in an infected joint, as pus frequently tracks along it, and breaks through to form an abscess in the ham or calf. This diverticulum we have found involved in almost every case in which amputation has been performed for a badly infected joint. It will be seen from the foregoing description that the external semilunar cartilage is covered for part of its extent on the outer surface by synovial membrane (figs. 8 and 14), thus differing from internal cartilage (figs. 8 and 13.)

Bursæ.—There are many bursæ in the neighbourhood of the knee, but only those that are likely to communicate with the joint need detain us here. The suprapatella bursa has already been mentioned. A large and important bursa is that between the inner head of the gastrocnemius and the internal condyle of the femur. This bursa sends a communication between the tendons of the gastrocnemius and semimembranosus, and frequently communicates with the joint. It is shown in figs. 7 and 10, and I have added it to the original drawing in fig. 6. We have found that this bursa frequently shares in the infection of the joint. Movement is liable to pump infective matter into it from the joint, hence the necessity for absolute rest by fixation on a suitable splint. It is interesting to remember from one's experience of civil surgery that when enlarged and tense this bursa is easily emptied into the joint during flexion, while in the extended position its contents cannot be readily returned on account of the valve-like communication which is made tense by placing the limb in the latter position. There is also a bursa between the outer head of the gastrocnemius and the external condyle, but this is inconstant and rarely communicates with the joint.

I am indebted to Miss Rea, Mr. R. Hunter, and Mr. Samuel J. Smyth, of the Anatomical Department, Queen's University, Belfast, for the drawings which illustrate this paper; and to Major Johnston, R.A.M.C., and Captain Oldham, R.A.M.C., working in France, for the radiographs of joints injected with bismuth.

SOME MUSINGS OF AN IDLE MAN.

By Colonel R. H. FIRTH.

Some friendly critics tell me that my contributions under this title are difficult reading, too philosophical and beyond them. More than one say, Cannot you give us something light, suggestive of a happy day rather than of a mournful end? I do not know what the Editor will say, but I leave the decision to him of publishing this instalment, which, admittedly, is couched in a lighter vein and devoid of science, philosophy and professionalism. One has rummaged through old note-books and found some odds and ends jotted down in idle moments. In this way this article has almost composed itself. "Thoughts that breathe" will not always make written "words that burn," for these are apt to cool down as they are traced on paper. Still, the Journal is welcome to my musings and I have but one fear, and that is the danger which lurks behind and beneath all writings of the kind—namely, egotism. A further risk is that pages like these are ever ready to receive the perilous confidences of self-complacency, like an old lady's humble companion or the father confessor of a voluble devotee. To quote the blunt truth enunciated by that shrewd and caustic lady, Madame de Sévigny, one remembers *on aime tant à parler de soi.*

I.

A fear has just been expressed of egotism; but why not egoism? Wherein do they differ? The one is a weakness of temperament, the other a vice. The one arouses ridicule, for it is frequently absurd; the other inspires aversion, for it is unsocial. Egoism is a modern product in the main, but the vice must have shown itself individually in all ages. The egoist is one who, uncalled by necessity for exertion and led by nurture to resolve all things into self, feels no value for public opinion or, feeling it, believes himself above it. Devoid of warm affection and independent of all sympathy, he is ever on the side of good form or taste because no predominant impulse leads him to its violation. He is a type who breaks no conventions nor shocks a prejudice, but, devoted to self-gratification, never seeks it by any greater risk than is consistent with his habitual ease and place in society. Fortunately, the egoist is rare, and although the psychological causes of egoism

must exist in all classes, yet the true egoist must be sought especially among fashionable idlers who, if not occupied with themselves, have nothing else to be busied about.

On the other hand, egotism is of all ages, and the egotist must be a very vain man, though often a gifted and generally an amiable one. The trouble which the egotist takes to court public suffrage is a proof that he values opinion and, if he had many serious defects to hide, he would not so freely give himself up to public inspection. When accompanied by ability, egotism is infinite in its resources. When it cannot talk it exhibits, and for ever must be holding the stage. Heroes make excellent egotists; they bring their excuse with them and render their vanity respectable by the events on which it is founded. How well Shakespeare realized this when he made the egotism of the Moor win Desdemona, in spite of his colour. Gossip relates that a certain Judge Erskine was so noted for talking about himself that he was nicknamed Counsellor Ego. Possibly, he could scarcely have chosen a more interesting subject. Nearly all actors and actresses are apt to be egotists; they live so much before the public that they suppose the world to be always engaged with them, and yet live in so small a world that their sphere of observation is limited to themselves, their calling, their successes and their failures both before and behind the scenes. The highest order of egotism, and by far the most delightful, is autobiography. When the life of the writer is mere pretentious mediocrity, it is an impertinence and meets its just reward in oblivion ; but the egotism of genius, when associated with great public events, is a debt which must be paid to posterity. In so thinking, one recalls the memoirs of the great men who have written and the agreeable women who have left behind those charming pictures of themselves and the society in which they moved. In the long list of biographical egotism, two men ever seem to have escaped clean ; the one was Julius Cæsar, with his third person so familiar to us at school, a tactician in taste as in war, and Napoleon who ever talks of his ambitions and military combinations in a way that makes the individuality of the man disappear before his intellectual personality. In our own profession, it is to be feared there is much egotism, and to that weakness possibly is due the filling of many pages of our professional literature. It was said of Napoleon that he was but the half of a great man. Surely that is more than can be said of every hero or of most men who wish to stand prominently before the world. The verdict of posterity probably will be that the greater number are not more than a fourth part of a great man. So much for egotism.

II.

In the mess in which I live, there is a man who has a laugh which is like no other man's laugh. True, it is the expression of its owner's hilarity, but is at once so hard, unmusical, forced and non-infectious that it gets on one's nerves. Sitting as one has to and listen to the raucous guffaw of our messmate, it has been impossible to refrain from thoughts on the whole commonplace phenomenon of laughing. In the first place, there is the plain, simple, natural and obvious laugh of the ordinary man; we all understand that, because it is unstudied, unlaboured and instinctive, and one which we can label as "the soul of pleasure and the child of mirth." That laugh has nothing to do with scientific niceties or artificial distinctions ; it comes by nature, is a true expression of feeling, and though its motives are doubtful they are really nobody's business and to be disregarded. Its great charm is its very obvious spontaneity and its inherent sympathy which makes it infectious. From this point of view, a natural and good laugh is the unique case in which the quality of infectivity is an asset and not a disability.

The laugh of the man who inspired these notes is what some would call "a horse's laugh." Now, inasmuch as horses do not laugh, the word horse used in this connexion has no reference to our equine friend ; it seems just as much appropriate as the use of the same word when we talk of horse-radish, in spite of the fact that horses do not eat either that vegetable or the horse-chestnut. The word horse seems merely to convey an idea of the tremendous energy of this kind of laugh, very much as one describes the strength of a steam engine in terms of so many of those animals. Possibly, the idea conveyed is about as definite and as well understood by people in general in the one case as in the other. Watching my friend, one realizes that, to achieve this species of laugh, the mouth is opened to its fullest extent with the head thrown back to quite forty-five degrees, and the laugh emitted in a rapid series of explosions. There is none of the crushed pumpkin sort of sound which frequently accompanies the ordinary laugh ; the tone is clear and sonorous, like something between a shout and a roar. It always seems to me to be an illogical laugh, because its exciting cause is so very often ludicrously disproportionate to the effect. If it were a logical or scientifically produced laugh, surely its cause might be supposed capable of exciting the risibilities of the sagacious quadruped whose name it bears, were he possessed of the requisite cachinnatory organs. So ponderous is this laugh that one

looks instinctively for some specially wonderful cause, such as an elephant booking his own trunk at a baggage office, or a man falling down and treading on his own nose; but, alas! it rises from nothing so unusual and humorous.

Another man at our table has the "half-laugh" and presents a true contrast to the quadrupedal convulsion of the other. This half laugh is a sort of sizzing and bears the same relation to the whole laugh that a whisper does to an audible tone. In uttering it, the producer opens his mouth very slightly, but he has an imitator, possessed of very good teeth, who opens his mouth wide. Both exponents make their laugh more effective by a trick of tilting the head a little on one side and partially closing the left eye, very much as a hen looks into a basket full of corn. The half laugh of these men suggests the analogy of half a pair of fire-tongs, of which it may be said it is of no use to anyone but the owner, and not at all calculated to act as a substitute for the whole pair. It is the sort of laugh one raises when the General Officer Commanding makes a bad joke or when trying to say a good thing oneself and missing it, you try to cover your retreat and hide discomfiture by appearing highly delighted yourself.

These reflections remind one that some men have the trick of laughing out of the corner of their mouth. In performing this feat, the mouth is pertinaciously closed except at one extremity. Whether it be the right or left corner of the mouth which is left slightly open for the emission of the characteristic sound depends on the circumstances. A man laughs out of the right side of his mouth and generally tilts it up when he is anxious not to laugh, and yet does so; or he wishes to conceal the fact that he is laughing at all, as when some familiar friend succeeds in making a fool of himself, or some one nearly rips a skirt off a lady's waist by treading on her train. The laugh from the left corner of the mouth is usually associated with a drawing down or doubling under of that buccal extremity. The point of variance between these laughs is the difference between up and down. The tone emitted is not very different from the others, but the symptoms suggest that its production requires a decided effort and is therefore hardly involuntary. This laugh is the refuge of the man who wishes to laugh but cannot bring it about, and means too often an attempt to conceal his chagrin at having most egregiously made an ass of himself. Quite a different affair is the laugh in the sleeve. The knowledge of its existence is confined generally to the individual indulging in it and its effects are not apparent. This laugh is

taken internally and privately, like a drink behind the door, and is altogether a selfish affair. It indicates a high degree of self-complacency and finds no response in others. Besides these varieties of laughter, we have the grin and smile. These do not amount to much as contributors to general hilarity but, to the observant, familiar examples are the smile of derision, the triumphant smile, the smile of superiority and the approving or encouraging smile; all these resolve themselves into so many smiles for, to and with a man.

We all know how difficult it is to draw tears from blockheads, except they be fuddled with drink and more or less maudlin. Still more difficult is it to draw a sympathetic tear from the self-sufficient. In both cases it is as difficult to raise a sympathetic or intelligent laugh; and, after all, surely the gift of laughing heartily and sympathetically is a proof of feeling equal to that of crying? Alas, for those who neither laugh nor weep, and doubly alas for those obliged to live with them. The more one thinks over it, the more impressed one becomes that there is an immense variety and character in laughter. Who does not recall the woman whose laugh is more beautiful than her face, and who can deny that her friends are all the richer thereby? One could write much on this subject, but refrain for fear of being laughed at. It would be an interesting diversion to prepare a catalogue of people who have died smiling and laughing, and still more interesting to know why they laughed or smiled.

III.

I may truly describe myself as a voracious reader of books, including novels, and nothing impresses me more than the difficulty there is to find a really good book in these days. This evil of bad books is probably no novelty. Whoever runs his eye over a catalogue, will be convinced that, in all ages, the number of really useful and valuable works bore no very large proportion to the entire mass of literature. Many of us are apt to imagine that Ovid, Virgil, Horace, Shakespeare, Milton, Johnson and many others who have written fine books had the whole field to themselves, and that the literary effort of their days was confined only to their fine works. The unrolling of manuscripts recovered from the ruins of Pompeii, has proved that trash was written then as now; it may, further, be questioned whether, at the burning of the library of Alexandria, there were a hundred volumes utterly lost to the world which were not more serviceable as fuel for the baths than as food for the mind.

It is easy and tempting to act as censor of our modern literature, and say there are no more Shakespeares, Miltons, Bacons and Jeremy Taylors. But, is it reasonable? We might as well lament that there are no more knights-errant or cross-bowman. Every age knows its own wants and provides for them. Possibly, Milton would not succeed much better, were he to reappear in this twentieth century with a new "Paradise Lost," than Kipling and other moderns have succeeded with their poems. The hyper-critical or cynical may say that the British publishers are very inventive people for they produce more bad books than the rest of Europe. Apart from the fact that it is doubtful whether that is true, the fact exists that there is much evidence of good books, and of an excellence which society requires. What is to be the standard of that excellence rests with the individual. What suits you may not suit me, and vice versa. A man is drawn by a sort of elective attraction to the works which harmonize with his intellectual peculiarities. That I have experienced a difficulty in finding what I deem good books, may possibly be due to the fact that I am out of joint with the times. Another way of looking at the same question is to say, that the frequency of bad books proves only that fools now employ their leisure in reading, instead of devoting their spare time to games, sports and active exercise. Few would advance such a plea, but I have heard it enunciated.

It may be worth while to consider briefly what has been the history and tendency of modern literary effort. After the development of the printing press, its first efforts were expended in disseminating the accumulated errors of a thousand years, which had previously been in the exclusive possession of the few. Since then, each successive generation has pretty equally divided its time between refuting the mistakes of its predecessors, and popularizing others of its own. Few can deny that pedantry, bad taste and some ignorance infect the earlier writers, notwithstanding their eloquence and energy. What passed for science was scarcely less mischievous than their false morality. Of theology it is dangerous to speak, but of the older medical books it is not unfair to say they were a garbled account of ill-understood facts, supported by a chaos of false inferences and illogical systems. As for law, each particular code was a monument of the barbarity and perversity of our species. Of all the works of imagination, with which the press teemed during the last three centuries, how very few live and are read by ourselves. History has ever been a record of errors, of party squabbles, and of views expressed according to the historian's

fancy. Again, each generation has had its crop of pamphlets, for the most part embodying the interests and views of the moment; these have fretted their little hour on the stage and then been consigned to the dust-bin. The rapid production of books in these times may be attributed to more rapid thinking as well as to more rapid printing; it is doubtful whether a work is really any the worse for being thrown off at high pressure.

Another cause for the multiplication of flimsy books is the universality of authorship; it is the fashion to write. When all sorts and conditions of people must read, all sorts and conditions will, and are tempted to, write; the annual quality of publications is less an exponent of the talent in the market, than of the minimum of wit, sense and utility, beyond which the public will not buy. An order of writers, peculiar to our age, are speculative traders who, treading on the heels of physicians, write books or pamphlets to puff their wares. Even cooks and confectioners can recommend the lightness of their pastry by that of their literary style, or advance the flavour of their wit as an index of that of their ragouts. In Shakespeare's time, a current phrase was "cutler's poetry," and we can boast of anthologies of safety razor makers and composers of soaps.

Reverting to the main theme of these thoughts, and the question whether any real evil exists in this multiplicity and consequent mediocrity of books, it may be asked, if none but good books appeared what would become of the critical reviewers and the outlet for their splenetic vituperation? It is well known that bad books made good reviews, and without the necessary supply of these, many would lose the opportunity of being witty in print. Reflection compels one to think it unreasonable and selfish in the wise or learned to desire that nothing should be published but what suits them; the whole should be amused, although all cannot afford to be wits and philosophers. As for the idea that bad books debase the intellect and morals of the public, one is inclined to think the facts to be the other way, and that it is the public who debauch and encourage the bad writers. Only the silly read silly books and the charge is a mere confounding of cause and effect. Books are, or ought to be, pictures of the human mind, but it is not every publisher and bookseller who will have anything to do with an original thinker, a man of science or a philosopher. Such works may be excellent and even confer a lasting benefit on the race, but they do not sell or, at best, make but a poor and slow return on capital. As an article of trade, we may say of books, that bad

is best; and he who writes too deeply for his age, might as well write in a foreign language. The mediocre, the foolish and the common place are the publisher's best customers, and to deprive them of their appropriate reading would be as politically unjust as it is economically impolitic. In literature, as in most things, we want a free trade.

Certain philosophers have explained the existence of moral evil as a necessary point of comparison for appreciating the blessings of life; if so, why may not bad books be tolerated, as contributing to the delight with which we enjoy the few that are worth reading? The same argument applies to error. Truth is caviare and unpalatable to the general public, and if given undiluted might lead to trouble. Looking at the question as a whole, I am disposed to think that few, if any, books are so totally worthless as not to contribute sometimes to the reader's ideas; and what they do not communicate, they may suggest. One man's opinion may be true, as it respects another's, though false to the nature of things. Such opinions are stages on the journey of knowledge, and they may serve the uninformed though the philosopher despises them. Again, the great output of books, even though many are bad or indifferent, is an instrument of commerce and multitudes are supported by the mere manufacture. It is by the printing of nonsense and ephemeral literature that publishers drive their motor cars, that the revenue is supported, and a host of workers maintained in comfort and independence. Convinced of this, I should feel few qualms of conscience in adding another volume to the mass, even at the risk of its being dull or foolish. If the purchaser finds, too late, that he has bought folly, let him put it in a handsome binding; for if gold and frippery will pass such qualities current when incarnated in a fop, they will perhaps do as much for them when embodied in print. At all events, the volume will fill a shelf as well as better books, and this, after a time, becomes the destiny of the best authors.

IV.

My present quarters are somewhat unusual, one need not say where, and they compel the frequent contemplation of a dilapidated chimney, especially as I lie on my bed. Before it had been knocked about, I am sure that chimney was odd looking, most certainly it is now and verging on the comical. As I lie and look at the old chimney, I feel convinced that chimneys have characters.

One recalls the many funny-looking chimneys at home and realizes that they are very like human people and credits them with minds, dispositions and temperaments. Judging by the frequent troubles they have and cause, chimneys surely have diseases and often want their doctors. Are they not affected by east and north winds just as much as any of ourselves, and have they not their own inexplicable fits of moroseness, and are they not testy when contradicted, just as ourselves? I suppose there is a faculty of smoke-doctors and doubtless learned and respectable; but whoever heard of a chimney being cured? The truth is, a chimney's disorders proceed generally from its original physical constitution, and one might just as well talk of eradicating an hereditary disease from a human being. The only remedy is to destroy the chimney altogether and make a new one.

Circumstances govern us all, and chimneys too; hence the maladies which affect chimneys proceed usually from their situation in life. A chimney of my acquaintance once proved this in a remarkable way. It was a young chimney and had a juvenile vivacity which even the east wind could not repress, but on the whole was wonderfully well-behaved. However, a day came when it developed irregularities in its conduct. Doctors were called in, who examined the patient and prescribed certain kinds of cap to be put on his head. This was done but, instead of recovering, the chimney became worse and seemed, by the increased vehemence with which it repelled the advances of the smoke, to indicate that the doctors did not understand the nature of its trouble. Alas, it was not the body but the mind of that chimney that was diseased; envy, pure envy, was the cause of all its ailments. A consultation of specialists located the cause of all its woes in the presence of a tall and threatening gable near by and whose chimneys carried their heads much higher than that of the afflicted chimney in question who, once he was allowed to carry as high a head as his neighbours, never gave any more sign of sickness. Although we can allow that chimneys may be jealous of each other's heights, and sometimes look enviously at the honour or prosperity of their neighbours, I do not think that they are in general a democratic people. Some present a curious spirit of meekness which seems to fit them best for the lower walks of life, where they are content to exercise their calling under the lordly protection of some neighbouring stack of chimneys, and without fretting about ideas of equality.

Few will dispute that chimneys are sensitive things and, perhaps, some will credit them with speech. I confess that I have

never heard them pronounce an articulate word or carry on a conversation ; but, I am quite certain that they can howl. In a high wind, I have heard a chimney almost speak ; in these cases, it may be that they are only expostulating or quarrelling with their enemy the wind.

Then there is the interesting topic of cleaning chimneys ; they are like children and very fond of getting dirty. This suggests that noticeable set of men, called chimney sweeps. An old schoolmaster of mine used to call them the angels of darkness, in contradistinction to bakers, whom he dubbed the angels of light. If you meet either class, when dressed in your best clothes, the one is capable of being as great an annoyance as the other. An interesting point in connexion with chimney sweeps is, they see and explore a part of the world which nobody else does ; especially did this feature apply to the old type of chimney sweep and climbing boy of sixty years ago. When a lad, one of my most favoured cronies was an old sweep who used to stimulate our imaginations with wonderful stories of his experiences, when cleaning and exploring the crooked and angular smoke flues of a departed type of house architecture. The remembrance of that old oddity suggests but one more instance of the severe practicality of this age, and how it has removed all romance and risk from what used to be a specialized and dangerous calling.

V.

A little while ago, I was asked to buy a fan for a lady. The commission was somewhat out of my line, but it necessitated a visit to a fashionable emporium for those articles, and suggested some reflections. The invention of the pretty bauble, known as the fan, is attributed by Madame de Genlis to a demand which arose for a foil to the excessive modesty of the ladies of the French court before the Revolution. In the time which preceded that terrible event the fan was an object of necessity to screen the blushes of the timid and bashful who used them in defence against the crude and often obscene witticisms of the court gallants. Madame de Genlis wrote "in times when ladies often blushed and desired to hide their embarrassment or timidity, they carried large fans which were at once a veil and a countenance. By agitating the fan, the female concealed herself." In these days, ladies blush but little, and may be said to be not at all timid and possessed of no desire to conceal themselves ; to the modern, the fan is but an ornamental mechanism for obtaining a circulation

of air. What a falling off since the times of the Palais Royal or Cremorne, and of the little suppers at the Parc Monceaux or Vauxhall, when the King's mistresses displaced his ministers and traced out plans of campaign with their rouge, and used their patches for field marshals; when nothing was natural but the children, and nothing moral but that which was past the power of sin.

Like everything else applicable to human use, the fan had its origin in necessity. It is purely an oriental device and was invented for personal relief and convenience in hot climates. A Chinese dandy would no more be seen without his fan than a Chinese belle would; and the fan of the Nawab or Rajah serves far better purposes than concealing the blushes and embarrassments of his wives. The suspended domestic fan of our Indian bungalows helps to keep us cool and scares the mosquito. The fan even plays a part in the ritual of both the Roman and Greek churches, and is the lineal descendant or representative of primitive needs when the deacon used a fan to keep off flies from the officiating priest. In the present day, the form or symbol survives the want.

Fans came into England with other eastern objects of use, ornament or curiosity. The fan with which Queen Elizabeth is said to have graciously tapped Sir J. Perrot, an Irish Lord Lieutenant, would knock down a modern courtier. In the time of Charles II, a French fan was a fatal gift, for that which saved the modesty of Madame de Genlis' ladies purchased too often the honour of the maid of honour of the English court. It is easy to be satirical, but are our present day practices any better? Other times, other modes; the form only differs. The fan, however, was not the great rampart thrown up before the citadel of English modesty under the Stuarts. The modesty of those times had a queer habit of going to see plays so immodest that it was deemed necessary to resort to a mask for covering the face, while the fan was retained simply for the innocent purpose of "giving coolness to the matchless dame. To every other breast a flame." The tactics and manœuvres, necessary for the operating of these double purposes, produced the well-known exercise of the fan, so delightfully detailed by the old *Spectator*. At last, in the decadence of manners, this elegant little implement of the coquetry of our ancestresses fell to be a mere article of utility, returning as all things must to its origin. Our ladies of the late 18th century appeared, during summer, with a good housewife-like green fan to keep off the sun, and the fan of "ma tante Aurore" was the only fan

known to our Aunt Tabithas. The diffusion of French philosophy at length banished this instrument as an indispensable part of the British matron's toilette; the parasol was found more convenient, and the fan, employed only to cool the matchless dame, was reduced to that fairy size we know so well and to which Madame de Genlis once gave the reproachful title of *éventail imperceptible*. One drops the fan and thinks truly the history of fashions is but the history of manners flavoured with vanity, and perhaps not so frivolous as some imagine.

VI.

Most of us, from time to time, must have wondered over the great problem of man's nature, his character, the conscious power to reason and even sit in judgment on our fellow men. I know that I have, and how Man is still the great enigma and an ever absorbing theme of curiosity. To solve this problem, various conjectures have been made and many pages of philosophy written. But, of all the results, since the time when Diogenes went about with a lighted candle, looking into the breasts of men for honesty, very few have given a satisfactory answer. We all are familiar with Shakespeare's lines, how "All the world's a stage, and all the men and women merely players." If so, what a strange medley must the play be wherein each one plays his own plot; some tragedy, others melodrama, a few operas, and many farces. It must puzzle strangely the audience, if there be one; but, of course the poet meant to represent the players to be only exhibiting in masquerade. Another way to regard it is to say that we are all travellers, coming we know not whence as to an inn and, having enjoyed ourselves as best we can, inquired our way and perhaps paid our reckoning, trudge on towards an undiscovered bourne. In like manner, this world can be compared to a huge mart, to which each brings his wares and means, with the hope of a profitable trade and a final rest from toil and care. But whether this world be regarded as a stage for players, a masquerade, an inn, a school or a general mart, it does not aid us much in deciding what we individually are.

One could prose indefinitely on the views of metaphysicians, and all the host of charlatans who have endeavoured to find the key to man's character or nature by such devious routes as physiognomy and phrenology, but it would be like beating a dead dog. In man, there are too many cross-breed influences and his mind too highly developed for the signs to be anything but equivocal. What can we

care for the phrenological or physical developments of Newton, or Napoleon, or the Kaiser? We judge and know them by their actions. Every falling raindrop and the planets proclaim the character and mind of the one, a history and record of reckless ambition associated with the face of Europe drenched in blood gives us an insight into the true nature and character of the other two. No, think as we can, the only true tests of character are actions. In them only can we get a clue to a man's real nature; it is no discovery, but merely a reiteration in new guise of that old Latin tag, "Acta exteriora indicant interiora secreta." If the least merit attach to this musing, it is solely for calling up the ghost of departed knowledge, to renew its existence.

VII.

We all have friends or relations who are very good. A recent visit to one of my relations who is acknowledged, by all that know her, to be a very estimable person prompts me to ask the question, whether it is not possible to err on the side of virtue? From our childhood up, we have been taught to be on our guard against vice and the minor immoralities such as rudeness, vanity, arrogance, pride, impoliteness, self-confidence, etc.; but, how many of us suspect danger in virtue? Odd as it may seem, I am inclined to think that we have all been so urged, threatened and coaxed into such a hatred of vice and such a partiality toward virtue, as to lose sight of some of the evil consequences of the stereotyped education. The reader may be astonished and perhaps alarmed at my position, but I flatter myself that I am taking a view of the subject as correct as it may be original. Without being an advocate for vice, is it unreasonable to think that there are people who err on the side of virtue, who carry it too far, and who think it affords them an exclusive claim for superiority? In plain language, it is possible to be too good, make virtue an unmanageable thing, and sacrifice every person's convenience to mere goodness.

Let us look a little closely into the matter and observe the bad effects of some of the virtues. Now, what people call frankness is a virtue yet, much as one hates duplicity, it is obvious that most disagreeable effects spring from frankness. There are people who feel it a duty to say cruel things, just because they think them; they broach awkward subjects, wound generous feelings and make unnecessary disclosures about themselves and others because they are too severely honest to deceive, or suffer deceit. They

sting you to the soul in the most affectionate way by saying, "You must excuse me, my dear, I have no wish to hurt your feelings"; or "You know I am your best friend, but I esteem it my duty to be perfectly frank with you." Who has not experienced such phrasings? Again, there is the superior person who cannot think how anyone can wear imitation ornaments, and implies by the remark that the wearer is guilty of a deliberate falsehood, inasmuch as it amounts to an intention to deceive the world, and proclaim as true what is known to be untrue. Think of the consequences which this doubly distilled purity entails. It forbids a thousand things, which are not only ornamental but useful and necessary. One conjures up an endless vista of innovations upon the established order of society. Half the lawyers would abandon their clients without a trial; the doctors would kill their patients at once, by telling them they would probably die in the end; the portrait painters would have to dismiss their sitters with "Really, Madam, you will only make yourself ridiculous by being exposed on the canvas." Then, there is the fond mother who says, "Little children should be seen and not heard," or "Don't ask for anything, give half of what you have to your friends, above all things be obedient and never quarrel." No one will deny that these are excellent instructions, and eminently appropriate to bold, presumptuous, ungenerous or quarrelsome children; but too often they are rubbed into others whose tendencies lie in a diametrically opposite direction. These children want an infusion of less amiable qualities if they are to grow up as competent men and women. The virtues of generosity, obedience, modesty and tameness under oppression demand to be weakened instead of strengthened in their case.

Another thing about the ultra-good which is very irritating is their liability to be readily shocked. One could forgive this trait if their being shocked were simply a way of recovering their balance of thought, but unfortunately they use it as a way of expressing their sense of superiority. From this point of view, the virtues should shock us no less than the vices. Thinking it over, I am not so sure but what they do. We are taught to look askance at the man who, having great possessions, fails to sell all that he has and give to the poor. In real life, we should be greatly troubled regarding one of our friends if he took such a command seriously. Obviously then, the psychology of being shocked is not explicable in terms of triumphant virtue. The passion for being shocked, which some people readily display, clearly needs directing

into proper channels; this means a need to be shocked by the conventions themselves rather than by breaches of the conventions. The natural corollary to this is, that society progresses only in so far as it learns to be shocked not by other people, but by itself. If this were to come about, it is probable that Heaven would shock people far more than earth has succeeded in doing; therein lies at once our condemnation and our comedy. Meanwhile, we are likely to go on preaching against our neighbour's sins, and sinning against our preaching, till the end of time. That merely proves the completeness of our humanity; certainly it makes for balance which is a conclusion that ought to satisfy most people, even though it does not quite prove that there is a danger in being too good.

THE TREATMENT OF GUNSHOT WOUNDS BY PACKING WITH SALT SACS.

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The treatment of septic wounds by a pack which is allowed to remain in the wound for several days is so opposed to the usual teachings of surgery that at first sight its utility may be doubted. Nevertheless, such treatment has proved one of the most effective methods of dealing with septic wounds during the present war. It has also been found to be one of the most generally applicable procedures for the treatment of secondary hæmorrhage.

It possesses the great advantage of simplicity, an important factor when large numbers of cases require the attention of a limited staff. It also possesses the advantage of allowing transport to be undertaken without any anxiety regarding the dressing of the wound.

When it is necessary to drain a wound cavity, three methods are available. The ideal method would be to expose the whole of the interior of the wound so that its walls become exposed and more or less flat. There are anatomical and surgical objections to this as a rule, but it is occasionally employed, for example, when a rectal fistula is slit up, when an amputation is performed by the guillotine method and in certain cases of excision of wounds. Very inferior to this ideal method is the drainage of every pocket and cavity of a wound by drains. The interior of the wound is often very irregular and it is sometimes impossible to ensure that every pocket is drained. The third method, treatment by solid salt, imitates the first or open method, by draining every portion of the surface of the interior.

The treatment of septic wounds must fulfil certain requirements. The infecting microbes must be removed by some form of lavage. The outflow of lymph must be increased. The bacterial growth must be repressed and the coagulation of the discharge must be prevented. The tissues of the wound must not be damaged either by chemical or mechanical measures. It is common ground that free exposure of the infected tissues must be made in order that adequate drainage be obtained, but many opinions are held as to the correct method of dressing the wound.

These requirements may be met by the use of hypertonic solution of common salt.

It can be demonstrated experimentally that the higher the concentration of salt the greater will be its power of attracting water and albuminous substances. The "drawing" power of salt has been known for many years. Sir A. E. Wright's original lymphagogic solution consisted of a five per cent solution of common salt mixed with ½ per cent solution of sodium citrate. Early in the present War, Sir A. E. Wright recommended the hypertonic solution of salt for the purpose of lavage and repression of the bacterial organisms of septic wounds. Colonel C. B. Lawson invented tablets of compressed salt which he placed in the lumen of drainage tubes. Colonel G. Gray originated a modification of Sir A. E. Wright's hypertonic treatment by introducing the use of solid salt in the form of tablets. The tablets wrapped in gauze formed a solution of salt.

Packing wounds with gauze impregnated with concentrated salt solution must not be confused with the plugging of wounds with ordinary dressings. Wound cavities are only potential spaces, and in order to drain them the walls must be kept apart. Ordinary drainage tubes rarely drain every recess and elaborate methods are required to obtain drainage from every portion of the walls and avoid the shutting off of pockets. A wound cavity filled with gauze and salt may be regarded as being just as effectively drained as if the cavity were inverted and the walls dressed like a surface wound. Every portion of the surface area is drained by the osmotic action of the salt, and the capillary action of the gauze and bandage are continually removing the discharge and producing a continuous and automatic drainage and lavage of every portion of the interior of the wound.

The tablets of salt must not come in contact with the tissue or sloughing will often ensue. The wall of the cavity must be well protected by gauze.

The solid salt sac is an improvement upon the tablets. It consists of a two-walled sac of suitable size made of bandage, between the layers of which four layers of gauze are placed. The interior of the sac is filled with salt and the tail of the bandage forms a drain.

The sac is made by laying a strip of open woven bandage about a foot in length flat on the table. On this strip, four layers of gauze are placed the same width as the bandage but about four inches in length. On top of the gauze another strip of bandage is

placed. The sides of the bandage strips are then brought together by doubling the bandage in its long diameter and sewing to form a sac. The sac is filled with salt, a few stitches are put in to close the mouth.

These sacs are made in several sizes, sterilized in an autoclave and stored ready for use. One or more of these sacs is used to pack wounds, the spaces between the sacs being filled with gauze. A tube of perforated zinc or rubber may be passed into the depth of the wound in cases of large septic wounds.

Long slender sacs are made to fill bullet tracts. Small sacs are made for draining tracks in the brain. The free end of the sacs are passed into a vessel containing saline solution and the wound then drains by capillary drainage. A fine rubber tube may be run in along each sac, and drip irrigation carried out if required. The salt remains undissolved for several days and when the sacs are removed from a wound at the end of a week undissolved salt still remains.

The frequency with which wounds are dressed often depends upon empirical convention rather than on a scientific or clinical reason. The wounds are often dressed without any clear idea of the reason for removing the dressings. A dressing sticking to a wound is frequently torn off, tearing delicate granulation tissue, undoing the healing of the wound, and exposing raw surfaces for septic absorption. A more unscientific treatment cannot be imagined. In some cases, it is said, the wound is dressed in order to remove the discharge. This is simply an admission that the dressing has been acting like a cork in a bottle. A rise of temperature is another reason given for removing a dressing, but if the wound is being properly treated, changing the dressing will not lower the temperature.

There are two ways of dressing a wound so that no harm is done by the changing of dressing; one is to keep a light dressing continually moist so that its removal is not felt by the patient and no tissue is damaged; the other is to leave the dressing until it is quite moist and can be removed without pain.

The dressings of deep wounds is too often merely a ritual, the dressings and drainage tubes are removed and replaced by clean ones, but the complicated series of recesses which make up the interior of most wounds cannot be reached. They may be reached by irrigation, but some portion of the wound will escape the distending effect of a drainage tube, and the walls will fall together and a pocket will result.

The effect of the salt sac is to form a concentrated solution of

salt which promotes the resolution of inflammatory induration and aids the separation of dead tissue by solution of coagulated lymph. A powerful outgoing stream of healthy lymph is produced which carries microbes and debris out of the wound and retards the bacterial growth within it. It is unnecessary and undesirable to continue the action of this hypertonic solution of salt once the wound becomes clean. If the wound is clean, the sacs are removed in from five to ten days and treatment by normal saline instituted. If the wound is foul it is either again packed with salt sacs or dressed every forty-eight hours with gauze soaked with twenty per cent salt solution. When the patient's temperature remains high and his general condition is unsatisfactory, it is fair to assume that a streptococcus is present. The presence of healthy lymph induced by the salt sacs does not aid in dealing with the streptococcus, but it appears probable that the most effective defence the body possesses against this organism is the white blood corpuscle. When normal saline is used the wound hitherto bright red becomes covered with a grey film. This is caused by the protective layer of leucocytes which act as a barrier against further invasion until the healing is completed by the ingrowth of epithelium. The hypertonic solution is therefore changed to normal saline when streptococcal infection appears probable.

The advantages of a dressing which does not require attention for seven or eight days will be obvious. The patient is saved the pain and inconvenience of frequent dressing, there is a diminished risk of secondary infection and there is an enormous saving in material. The salt sacs have been found useful in many special instances. They were first devised for the drainage of septic wounds of the brain. Exceedingly septic wounds of the orbit with destruction to the eye have been treated by salt sacs after removing the orbital contents and removal of loose septic fragments from the bony wall of the orbit, with uniformly satisfactory results. Cases of secondary hæmorrhage associated with septic comminuted fractures of the upper part of the shaft of the femur have been packed with salt sacs. No recurrence of hæmorrhage took place and when the sacs were removed eight days later, a clean granulating wound remained. The removal of a septic foreign body, whether bullet, shell fragment, or shrapnel, is only the beginning of treatment; a septic cavity and track remains which may prove very difficult to drain and dress effectively. It has become our routine treatment to simply wash out the cavity and pack with salt sacs. The soft nature of the sacs, if they are

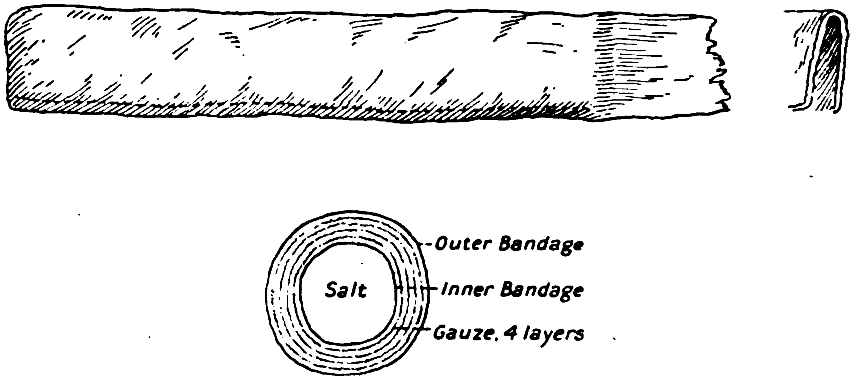


FIG. 1.—A large salt sac, a section of a sac, and a small salt sac are shown in the figure. The wall of the sac is composed of two layers of bandage between which four layers of gauze are placed. The action of a cigarette capillary drain is in this way combined with the hypertonic action of strong salt solution. The sacs are made in several sizes and when filled with salt are sterilized in the autoclave.

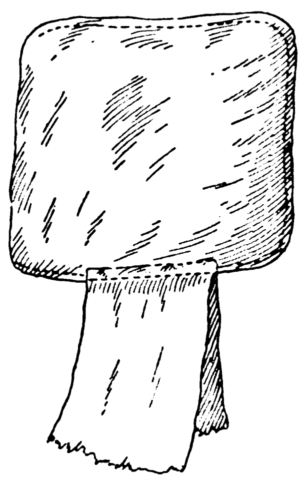


FIG. 2.—A flat salt sac composed of the same material as the cartridge variety. These sacs have been found useful in dressing large flat wounds, such as amputation stumps.

dipped into water before insertion makes it very easy to completely pack a cavity. The sacs accommodate themselves to the size and shape of a cavity and it is rarely necessary to add gauze to the packing. Large septic cavities associated with fracture require a drainage-tube to be inserted among the salt sacs.

The dressings become somewhat offensive at the end of a week but the odour appears to be quite harmless. The addition of the powder eupad (hypochlorous acid) to the sacs would obviate the smell, but if the smell of the drainage causes the patient to be given what is practically open-air treatment, its inconvenience will be more than compensated for.

I think it will be admitted that a method of treatment which saves the patient the pain and inconvenience of frequent dressing, which forms an efficient method of preventing hæmorrhage, and saves an enormous amount of labour and material is a good method provided its results are equal in all respects to other methods of treatment. I consider that the results are not only equal, but better than any other known method, provided the technique is properly carried out. It appears rational to add an antiseptic to the salt in foul cases and eupad appears to be the most useful. Its addition certainly appears to do no harm in my experience and my only reason for not using it as a routine treatment is that the plain salt gives such excellent results that it appears unnecessary. The offensive odour of the wound may in a great measure be obviated by its use.

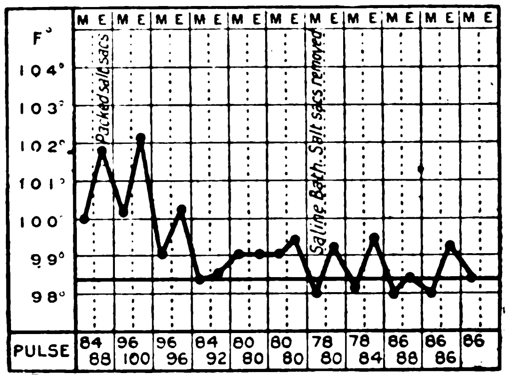
Sacs filled with eupad and salt in the proportion of one to three are destroyed in the autoclave owing to the corrosive action of the hypochlorous acid upon the fabric. A convenient method of combining the eupad with salt is to pack the wound with ordinary salt sacs sterilized in the autoclave and introduce into the middle of the sacs without touching the wound an unsterilized sac filled with eupad.

Six days may be said to be an average time for the sacs to remain in the wound. The temperature usually falls to normal within that period and a rise of temperature is apt to follow dressing the wound. This rise of temperature can usually be avoided by irrigating the wound for some hours before removing the salt sacs.

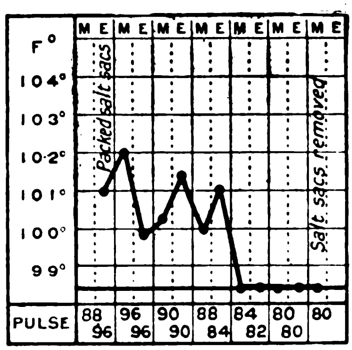
The successful results of this treatment largely depend, as all treatment of septic wounds must, upon an early attack on the sepsis and upon the thoroughness with which it is possible to remove septic and necrosed tissue.

This treatment has formed the routine treatment in a large

series of cases; the following charts demonstrate the reaction of patients to the more concentrated and normal saline solutions:—

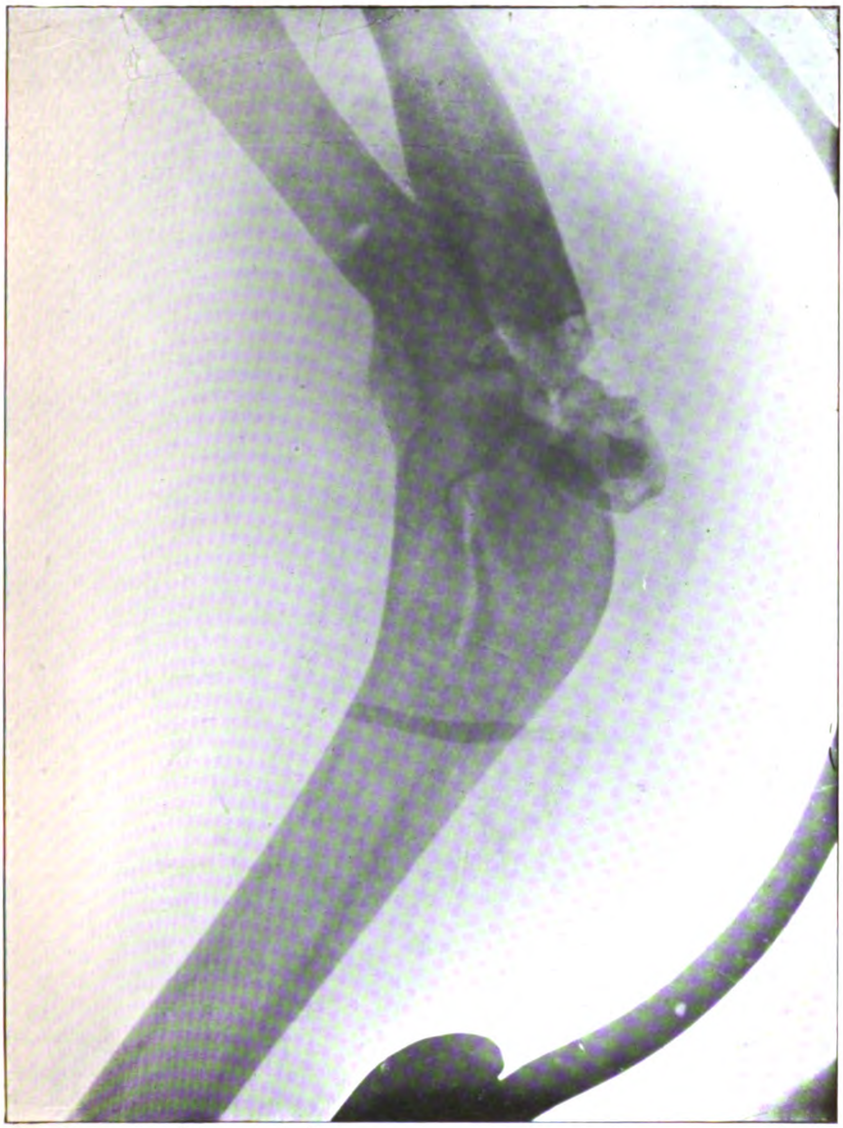


CASE 1.—Bullet wound left forearm. Very extensive comminution of radius and ulna. Extremely septic wound. The wound measured eight inches by three. Packed with salt sac and dressed on the sixth day. The wound was healthy and granulating. Normal saline was then employed.



CASE 2.—Shrapnel wound left axilla. Foreign body removed from under pectoral muscles and cavity packed with salt sacs. The temperature became normal four days after the operation. The sacs were removed on the seventh day. When the sacs were removed, about two ounces of pus escaped. The retention of pus made no difference to the patient's local or general condition. This accumulation of pus has very rarely been noticed and was probably due to imperfect packing of the whole wound.

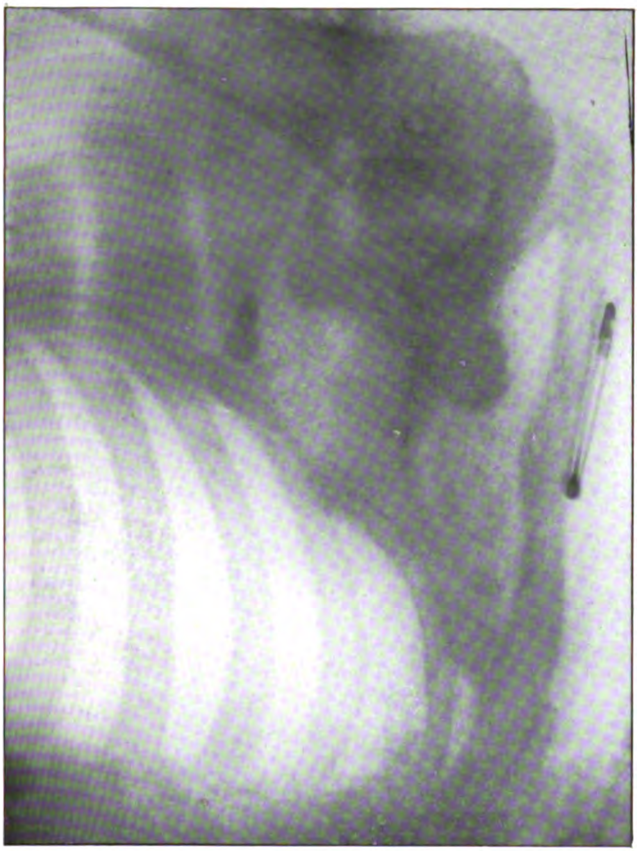
CASE 1.



Extensive comminution of radius and ulna.

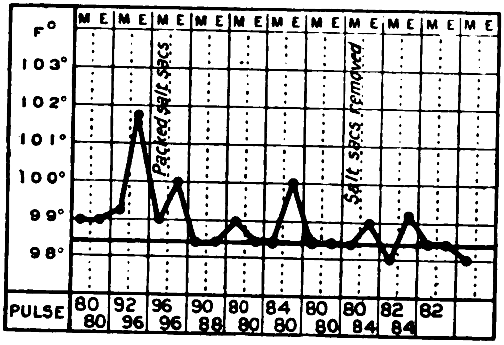
To illustrate "The Treatment of Gunshot Wounds by Packing with Salt Sacs," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

CASE 2.

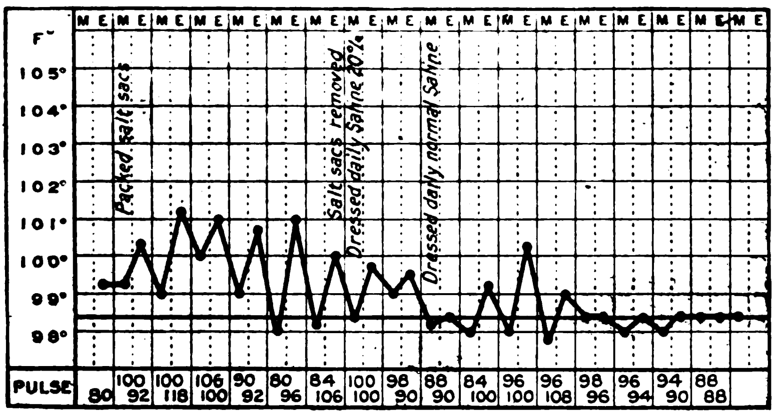


The missile is shown in the axilla lying upon the chest wall.

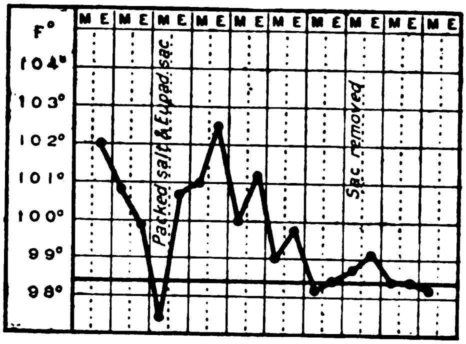
To illustrate "The Treatment of Gunshot Wounds by Packing with Salt Sacs," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.



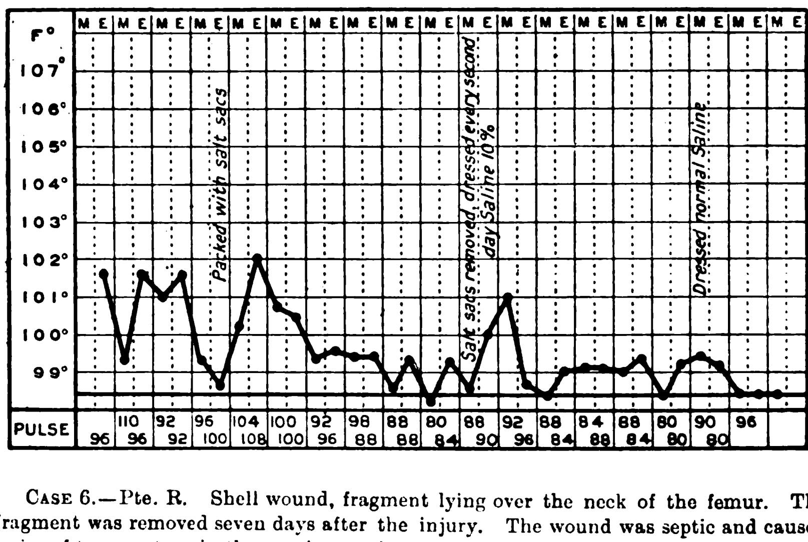
CASE 3.—Wound of left shoulder passing through acromio-clavicular joint with fractures of the acromion process. Shrapnel removed at a clearing station. On admission the wound was very septic. The wound was cleaned and packed with salt sacs. The temperature became normal on the day following the operation and remained normal, with the exception of a rise due to antitetanic serum, until the sacs were removed on the sixth day. The wound was then clean and granulating.



CASE 4.—Pte. F. Seven shrapnel wounds of left buttock and thigh. The missiles had been removed at a clearing station. On admission the wounds were very septic and large drainage tubes had been inserted. Under ether the wounds were irrigated and packed with salt sacs. The packing was removed six days later when the wounds were clean and granulating. The wounds were not repacked, but were dressed with gauze soaked with 20 per cent saline solution every other day. Eight days after the packing, the wounds were dressed with normal saline solution.

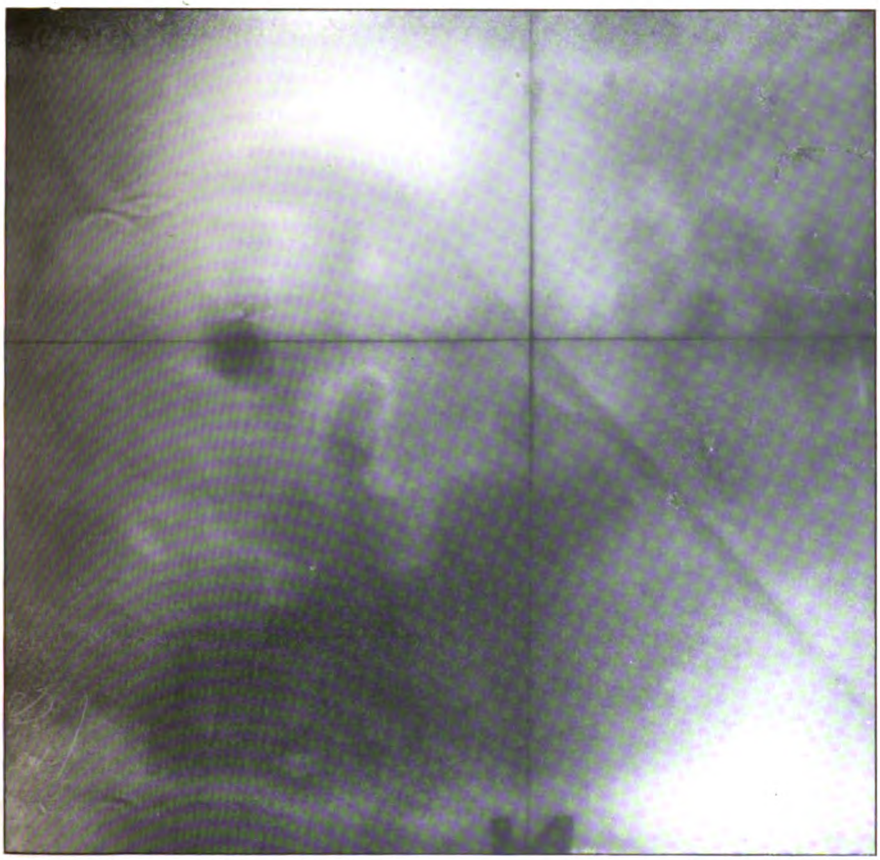


CASE 5.—Shrapnel bullet embedded in the sacrum, bone cut away sufficiently to allow its removal. The cavity packed with a salt sac containing one part eupad (boric acid and bleaching powder forming hypochlorous acid) and two parts salt. Retention of urine followed the operation but passed off three days later. The salt and eupad sac was removed on the sixth day. No sloughs were present and the wound was covered with clean granulations. The addition of eupad to the salt does not appear to make any appreciable difference to the result.



CASE 6.—Pte. R. Shell wound, fragment lying over the neck of the femur. The fragment was removed seven days after the injury. The wound was septic and caused a rise of temperature in the evening to about 102° F. The wound was packed with salt sacs and was re-dressed seven days after the operation. The removal of the sacs caused a rise of temperature. The wound was not again packed with salt sacs, but was dressed every other day with gauze soaked with ten per cent salt solution.

CASE 5.



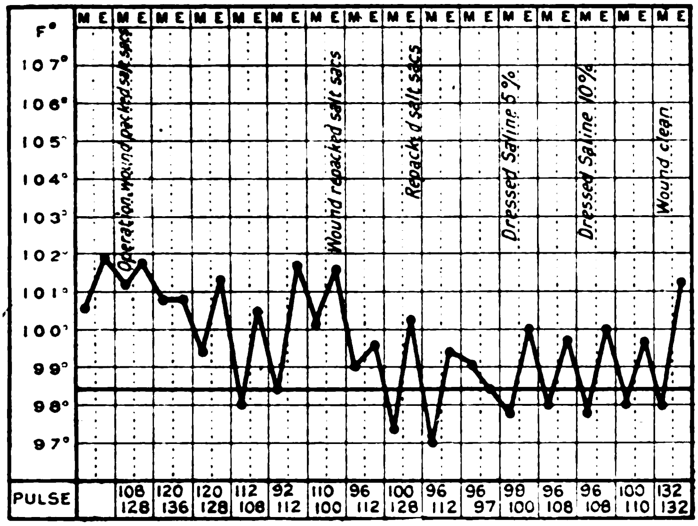
Shrapnel bullet embedded in the sacrum localized six centimetres in depth.

To illustrate "The Treatment of Gunshot Wounds by Packing with Salt Sacs," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

CASE 7.

Destruction of the olecranon process.

To illustrate "The Treatment of Gunshot Wounds by Packing with Salt Sacs," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.



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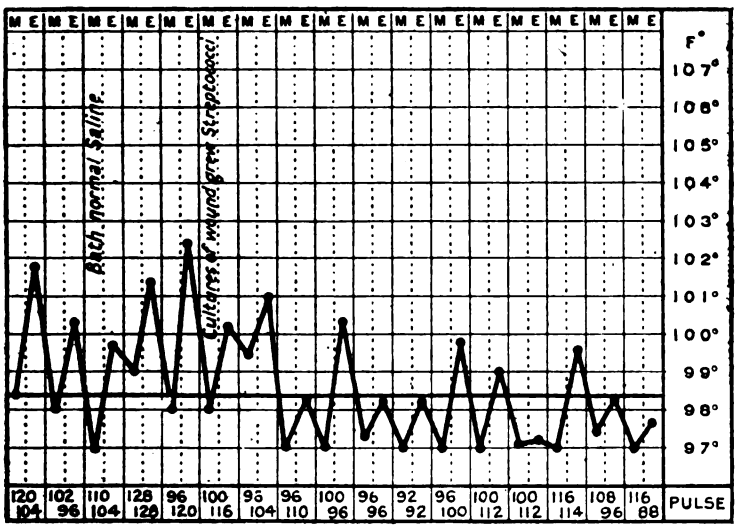
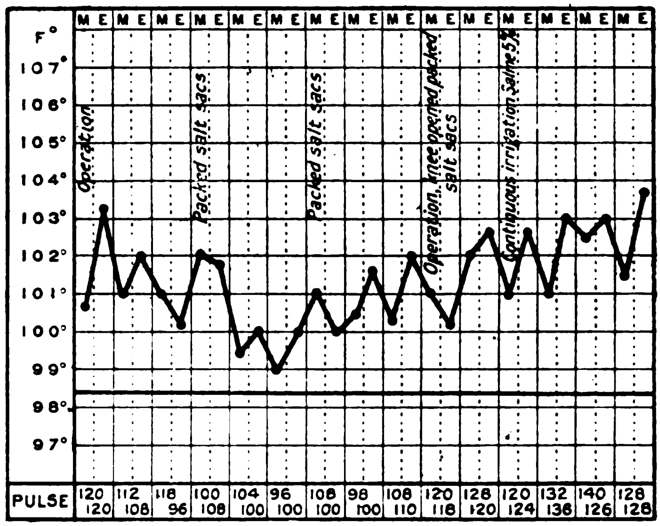


b

CASE 7.—Shell wound of right elbow. The upper half of the ulna was comminuted and the soft parts were severely lacerated and very septic. The dislocated head of the radius projected from the wound. The wound was treated by cutting a section across the point of the elbow, removing the comminuted upper portion of the ulna and the necrosed and septic tissue. The head of the radius was replaced. The flat wound which resulted was covered with flat salt sacs. The extensive nature of the injury and severe septic infection necessitated repeated packing of the wound. The continuance of pyrexia and increased pulse rate after the wound was apparently clean was due to a streptococcal infection which reacted to normal saline treatment.



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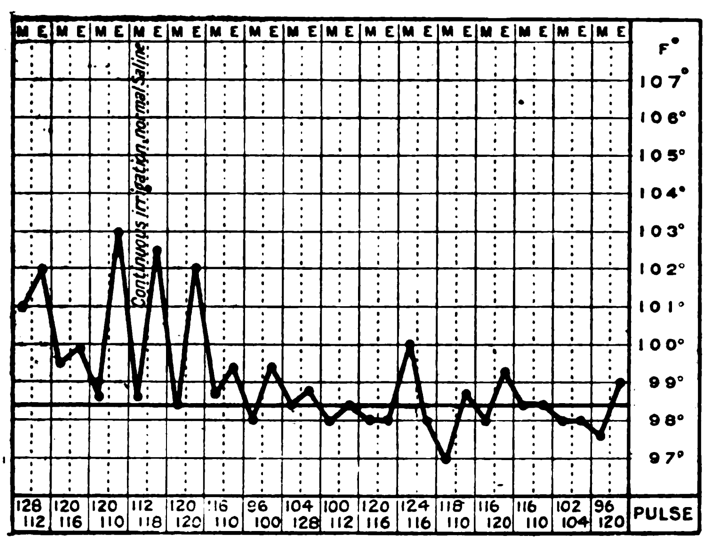
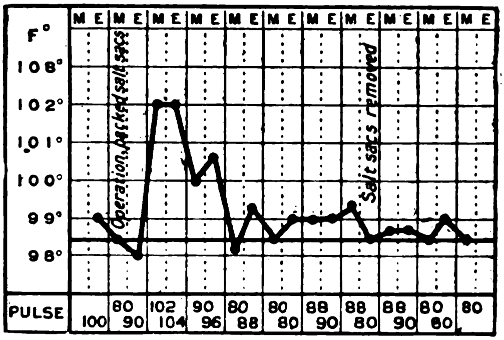
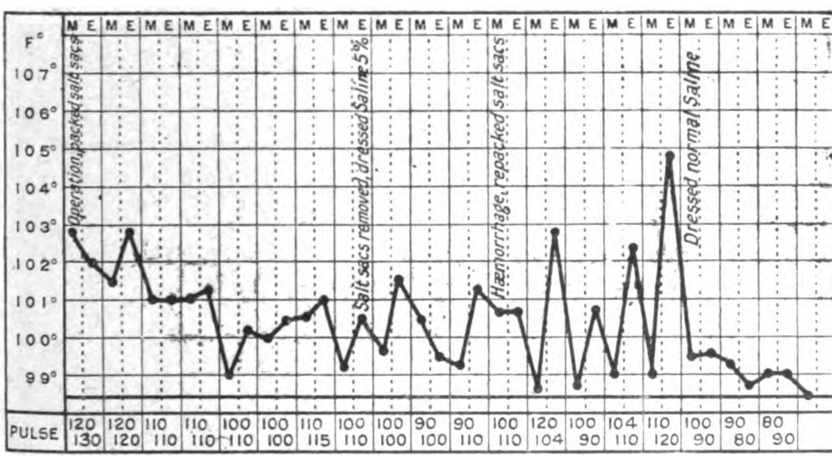


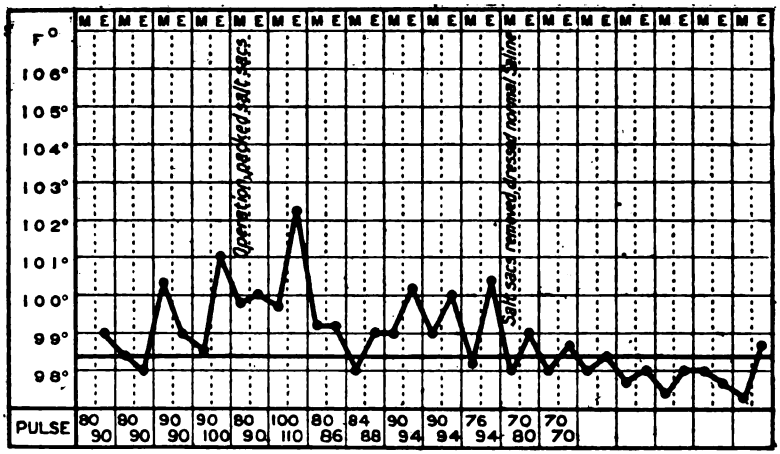
Case 8.—Pte. T. Gunshot wound right knee. The chart illustrates the effect of change to normal saline solution.



CASE 9.—Shell wound, thigh. A septic and sloughing wound, four inches by three, was excised, and a missile removed, four days after the injury. The wound was packed with salt sacs, which were removed on the eighth day.



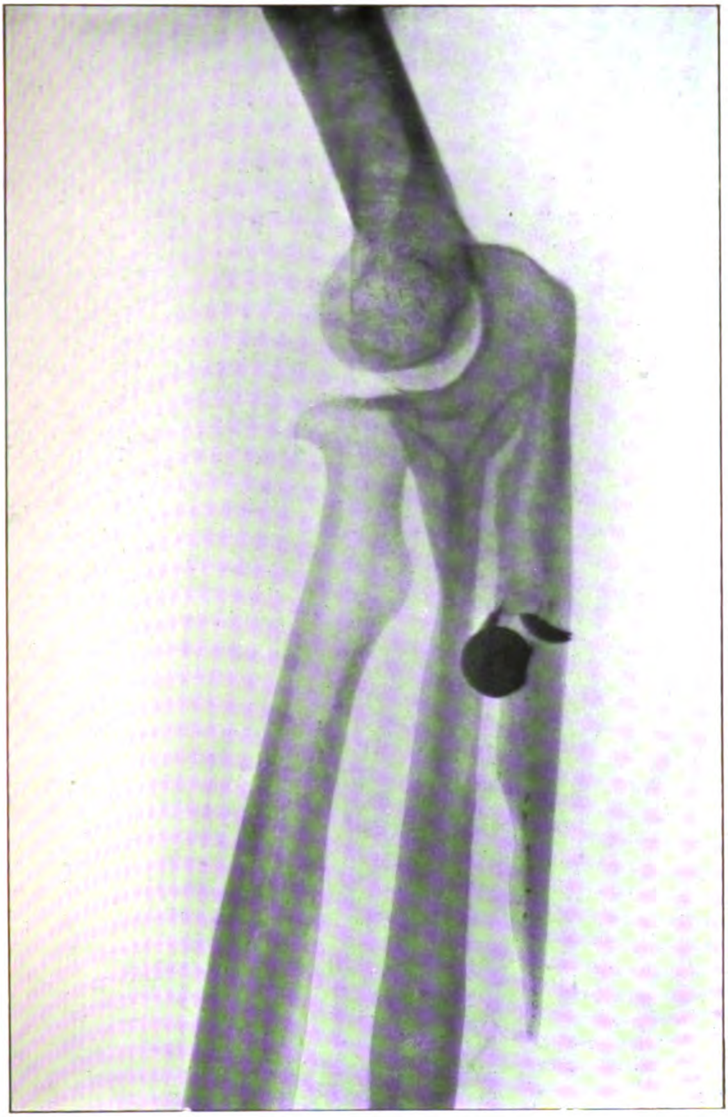
CASE 10.—Large shrapnel wound of buttock with great destruction of muscle extending to dorsum of ilium. Wound excised and necrosed tissue cut away. Packed with salt sacs. The sacs were removed on the eighth day. The wound was healthy and fairly discharging lymph. Dressing with five per cent saline was substituted. Secondary hæmorrhage occurred on the twelfth day after the operation. The wound was again packed with sacs which were left in for six days. Streptococci were found in the wound. The dressing was changed to normal saline, after which the temperature became normal.



CASE 11.— Pte. S. Shell wound left hand. Severe laceration of the back of hand with extensive destruction of the extensor tendons and very severe comminution of the first, second and third metacarpal bones. The wound was in a very septic condition at the time of operation. The septic tissue was as far as possible cut away and the wound packed with salt sacs. The wound was not dressed for seven days when the salt sacs were removed. The wound was found to be clean and covered with healthy granulations. Normal saline was substituted for the solid salt. The wound became covered with grey film. The chart shows the fall in temperature when normal saline was substituted for hypertonic treatment.

CASE 12.—Fracture of ulna by shrapnel bullet. The wound was in a very septic condition when the patient came under treatment. The wound was excised and the shrapnel removed. Salt sacs were inserted and the case was not redressed for seven days. The wound was then healthy and was treated with normal saline.

CASE 12.



Shrapnel bullet lying on the fractured ulna.

To illustrate "The Treatment of Gunshot Wounds by Packing with Salt Sacs," by Major ALFRED J. HULL, F.R.C.S., R.A.M.C.

Clinical and other Notes.

AMPUTATION AND RE-AMPUTATION.

By Temporary Lieutenant-Colonel G. A. WRIGHT, F.R.C.S.
Royal Army Medical Corps.
Emeritus Professor of Surgery, Victoria University, Manchester.

In the *Lancet* of October 9, 1915, the writer made some remarks upon the objections to "amputation" by plane circular section of a limb—the "guillotine" or "flush" amputation so-called. He suggested that the practice is an undesirable one in cases other than those of "gas gangrene" even if it is defensible when that condition exists.

Since the date of that communication several other cases of plane circular sections of limbs have been admitted here, some of which illustrate the objections to the practice.

Illustrations of three such examples are given to show the state of the stumps.

Case 1 (fig. 1), showing protruding bone covered with granulations, was that of Pte. B., aged 18, who was wounded in the knee by a rifle bullet on November 9, 1915. No record was received with him, but it appears that two operations were done and drainage tubes put in and finally the limb was removed on December 10, 1915. Seven weeks later he was admitted to this hospital. At that time there was a granulating area about three inches by three inches. From this area the end of the femur protruded—the bone itself was also covered with granulations. Re-amputation was done on March 22, by Captain Judson, R.A.M.C. This was evidently not a case of gas gangrene and we had no means of knowing why an ordinary amputation was not done and the need for a later operation avoided.

Case 2 was that of Pte. M., aged 21. He was wounded in Gallipoli, on December 15, 1915. The left knee was injured by a grenade. Sixteen days later the limb was removed on board a Hospital Ship. He was admitted to Whalley on February 1, 1916.

Thirty-one days after the operation the stump showed a large conical granulating area with $1\frac{1}{2}$ inches of bare dead femur protruding. The man was in bad condition and suffering from "chronic sepsis." By the middle of March, 1916, his general health had much improved and the stump was in the condition shown in fig. 2. On March 14 the soft parts were pushed back from the protruding bone and a tubular sequestrum of the shaft of the femur including its whole thickness and some eight inches long was withdrawn without difficulty. With the object of avoiding shortening as much as possible no formal re-amputation

was done, but so much new bone subsequently formed in the stump that yet another operation was required before the wound would heal. This case like the preceding one appears to have been an infected wound of

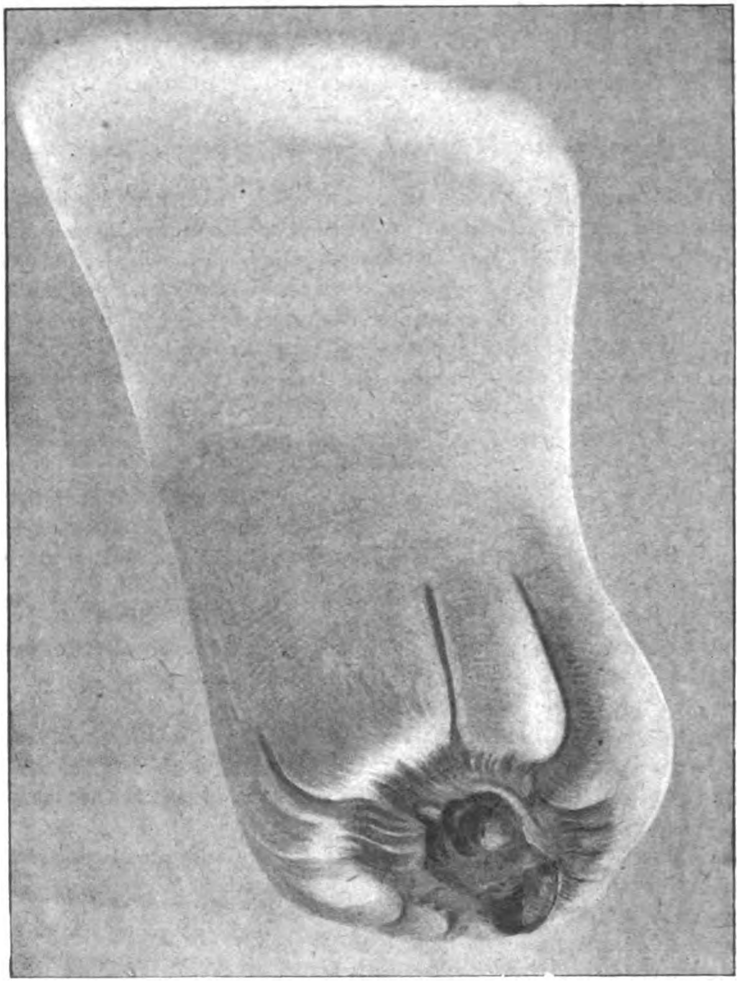


FIG. 1.—Pte. B. Wound of right knee by rifle bullet, November 9, 1915. Amputation through thigh, December 10, 1915. Drawing done about March 20, 1916, showing unhealed puckered scar

the knee-joint, but no gangrene was present. Incidentally it is of interest to note that complete separation of a sequestrum consisting of the whole thickness of the shaft of the femur took place in about ten weeks.

In his former paper the writer ventured to suggest that unless special

FIG. 2.

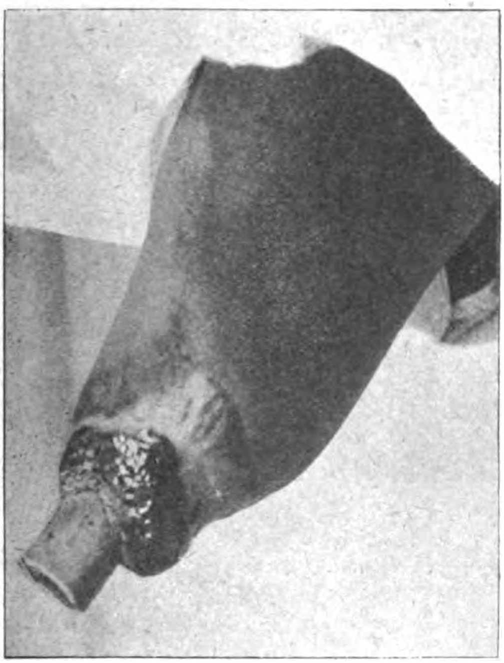


FIG. 2A.

FIGS. 2 and 2A.—Pte. M. Grenade wound of left knee, December 15, 1915. Amputation in lower third of thigh, December 31, 1915. Drawing and photograph taken about ten weeks after "amputation." The protruding necrosed end of the femur is seen.

conditions made it necessary the "flush" method of removing a limb should not be employed, and further experience of the state of the limb stumps after such an operation has tended to confirm the view that the practice should be restricted to cases of absolute necessity. This view is not limited to surgeons working in hospitals at home, but is shared by some at least of those operating at "the Front." It is, however, stated on authority that the result of the "flush" amputation is good and that it is intended that re-amputation should be done by one of the ordinary methods as soon as the wound is sufficiently clean.

FIG. 3.

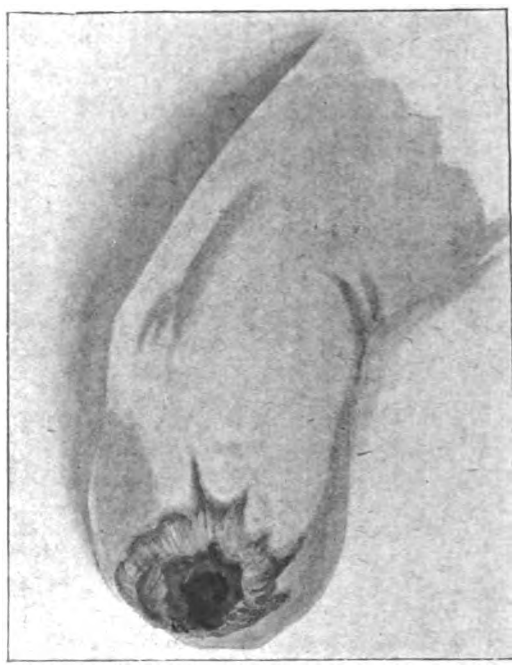


FIG. 3A.

FIGS. 3 and 3A.—Trooper D. "Flush" amputation through forearm. In this case the section left such a short stump of the forearm that a re-amputation would entail sacrifice of the elbow-joint.

Surgeons at home, of course, very rarely see gas gangrene, and if those at "the Front" say that leaving the flaps absolutely open is not sufficient and that a plane section is a life-saving necessity it is no doubt presumptuous to contradict, but the argument does not apply to operations for conditions other than gangrene, such as ordinary septic joints, etc.

It is in any case very unfortunate that a second operation and further considerable shortening of the limb should be necessary. The amount of this additional shortening needs to be borne in mind by the surgeon who performs the primary operation. In our experience mere shortening of the bone without complete re-amputation does not always result in a satisfactory stump.

Consideration of this question leads to the conclusions :—

(1) That it is hard for a man to be called upon to have a second amputation.

(2) That in some cases the further shortening of the stump may seriously impair the usefulness of the limb (figs. 3 and 3A).

(3) That the argument that the freest possible drainage and exposure is required and can only be provided by a " flush " amputation does not apply to cases other than those of " gas gangrene."

The value of traction upon the soft parts after a " flush " amputation is no doubt great, especially if it is employed early, but it will not in all cases make a good stump out of a bad one. A flap amputation with the flap turned back will, after adjusting the flap a week or more later, make a good stump.

AMPUTATION IN TRENCH FOOT.

The question of amputation and re-amputation has been forced upon surgeons at home in patients of a kind quite different from those who have lost limbs as a result of injury.

Men suffering from gangrene due to " trench foot" came over in considerable numbers earlier in the year, and some of them remain in hospital still. In not a few of these the question arises : what is the best course when part or the whole of a foot has been lost and a large raw surface is left ?

At first sight it would appear in many of these men that a simple section has been made through the foot or ankle without flaps as in other patients. More careful examination and inquiry—necessary in the absence of any notes—makes it probable that in many instances no operation has been done till the soft tissues have been entirely severed by natural processes and then that the dead part has been removed by simply dividing the bones or disarticulating them at the level of the " line of demarcation." In some even less than this has been done and portions of the metatarsal or tarsal bones have been left. On the patient's arrival at home the bones are seen bare and dead on the face of the stump surrounded by a larger or smaller area of granulating or cicatrized soft parts.

It seems that the practice of removing only structures obviously dead is in these conditions the wisest course though a secondary operation must of necessity be performed later. It is wiser to adopt this plan for the following reasons. It is impossible at first to be sure how much of

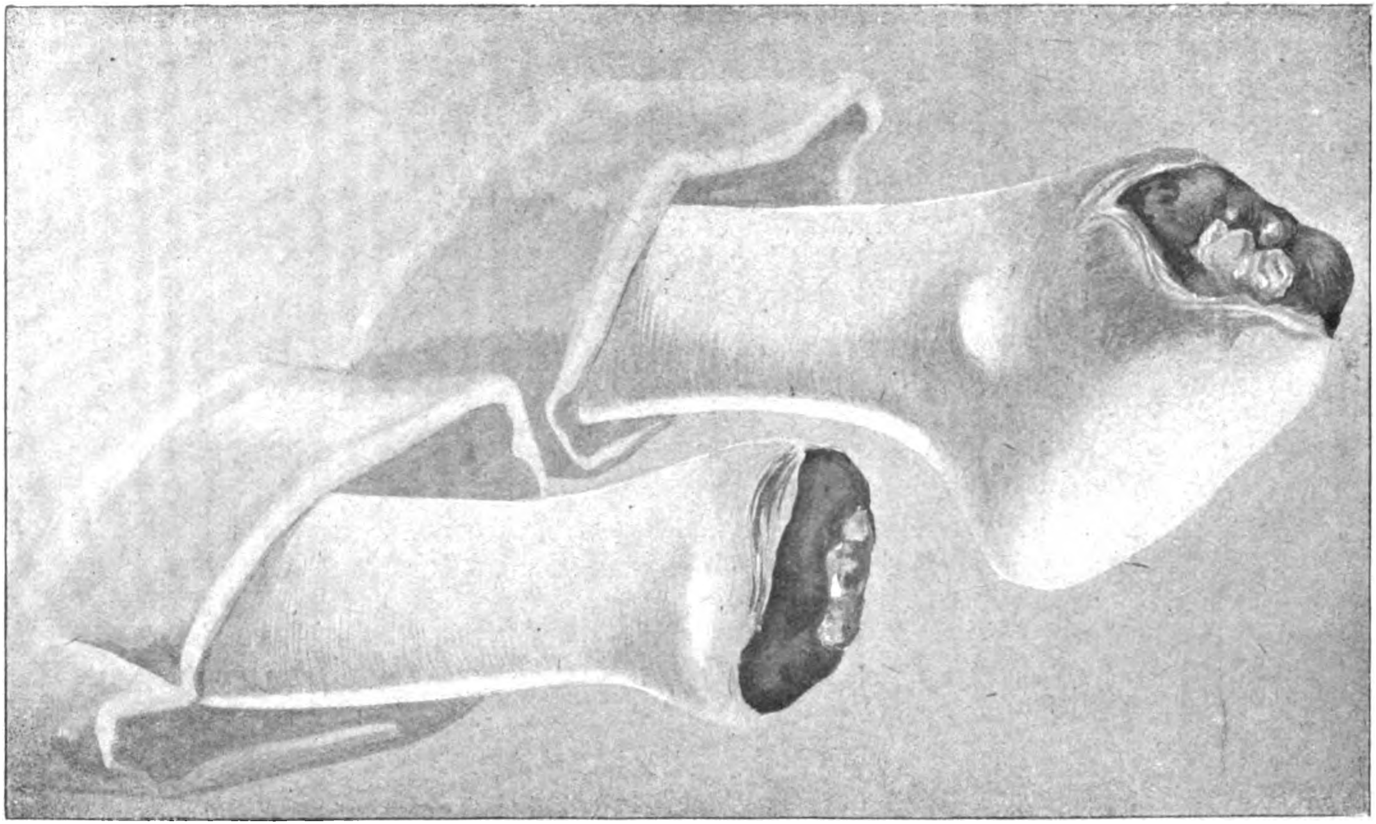


Fig. 4.—"Trench foot." Stumps after detachment of gangrenous parts.

the foot is viable and if any formal operation is done at once either too much or too little may be taken away. It is also likely that the injury necessarily inflicted by operation on tissues the vitality of which is already damaged may lead to destruction of a part of the limb which would otherwise have survived. It is now an only too well known fact that any disturbance of wounded tissues in these patients is apt to be followed by an acute septic process graphically described as a "flare." We may therefore conclude that it is judicious to do as little as possible until the extent of actual complete destruction is determined and the patient's general condition is improved by rest and care.

It is however to be observed that the stumps left under these circumstances are not such as would result from any of the formal operations, and that extensive and irregular scars may remain after healing has taken place.

The rapidity with which the dead parts are thrown off and the speed at which repair takes place in these patients is very remarkable, and sequestra become detached much more quickly than they do in the cases we are used to seeing in civil life. The bones above the line of separation seem to atrophy and become soft and rarefied like the bones in infantile paralysis. This has been very striking in some operations on these cases.

In some instances the extent of destruction of the soft tissues leaves no choice and a formal amputation at a higher level is called for. In others the mere removal of dead tarsal or metatarsal bones will enable the surgeon to provide a fairly satisfactory covering for the stump though such a stump may not strictly follow the lines of any recognized amputation.

It remains to be seen whether the stump left by "trimming" trench feet will be serviceable and stand the strain of wear or whether amputation at a higher level will be required. There has perhaps been hardly time even yet to test this matter by experience, but if a useful foot can be preserved it is clearly better to keep it rather than to sacrifice it for the sake of doing a formal operation.

In some instances a "Syme's" amputation or an amputation with a lateral flap (Roux) gives a good stump, but it appears that if any of the edge of the flap consists of scar tissue this cicatricial part is apt to break down again with very slight cause.

Personally I think it is wiser to wait and test these cases before advising amputation higher up.

It is very hard on the men to have to submit to repeated operations, but in these "trench feet" I fear it cannot always be helped, and since in any case they are not fit for further service a longer detention in hospital is, from a military point of view, of less importance. The drawing fig. 4 shows the condition of the stumps thirteen weeks after removal of the dead parts.

The writer has no wish to criticize the work of others, but while the

man at "the Front" is and must be the only one to judge in individual cases of immediate and life-saving necessities, those who see the later results of treatment are perhaps called upon to show in what directions any method may require modification.

The cases mentioned are reported with the sanction of Colonel Robinson, C.B., A.M.S., Officer Commanding the Hospital.

The sketches are the work of Cpl. Miller, R.A.M.C.

NOTES ON STABLE MANAGEMENT.

By Temporary Captain HERBERT A. LAKE, M.B., M.R.C.V.S.
Royal Army Medical Corps.

The Royal Army Medical Corps has supplied some of the best horsemen that Great Britain has known. The regular Royal Army Medical Corps officer, too, is generally a sportsman and has a considerable knowledge of horses, especially if he has served abroad. But at the present time many temporary officers find themselves with a horse of whose habits of life they know little, or, perhaps as transport officers of field ambulances, in charge of a number of animals.

It is therefore at the suggestion of Colonel Blackham, the A.D.M.S. of the cavalry division to which I belong, that these few notes are written with a view to helping those officers who have not had previous experience with horses, as grooms and subordinates are often ready to take advantage of a lack of knowledge on the part of the officer.

There is not much to be said about stabling on active service, often one has to be content with the most dilapidated shanty and at times the horse is fortunate if he has even a roof over him. But with a little ingenuity the transport officer can generally make the stable fairly comfortable. The flooring may be improved by draining and laying with ashes or gravel, and though straw or peat moss may be difficult to obtain under service conditions, sawdust, shavings or dried leaves make good substitutes. Although the horse is able to stand for long periods and rests while doing so, as practically all muscular strain is taken from the legs by a stout band—the suspensory ligament—yet he should be encouraged to lie down whenever possible. Improvised screens will keep out bad weather and draughts; but horses standing in unprotected places should be turned back to the wind, a position they always assume if free to take their choice. Projecting nails or hooks must be searched for and removed or knocked flat, as, unnoticed, these may be the cause of severe wounds. Animals inclined to kick or worry others should be either kept apart or separated by logs suspended from the roof.

Feeding.—Before entering into details of feeding, one or two anatomical facts will enable a medical man to understand clearly the principles of horse-feeding.

Firstly, the horse has a small stomach—comparatively very small—but an intestine of great size, where large quantities of food can be stored. Secondly, there is no gall-bladder, so that the flow of bile is continuous. The stomach is said to work at its best when not more than two-thirds full. A horse when turned out at grass is in the nearest approach to the natural state that we are likely to see him, and he then spends almost the whole of his time feeding. The stomach, as we have said, a small one, when sufficiently full, passes the ingesta continuously into the intestine at the rate that fresh food is entering.

Now the Army horse is allowed twelve pounds of corn daily and ten pounds of hay. To work at its best, three pounds of oats with hay are about as much as the stomach can deal with at a time, so it follows that he should be fed as often as possible, at least four times a day. "Little and often" then, is a sound rule for horse-feeding.

Corn, of course, is a highly concentrated form of food compared to grass, and bulk is essential, this being supplied by the hay.

Many horses bolt their food so that oats and hay are swallowed without sufficient mastication. Some do this because they are frightened of being robbed by their neighbours, and others from greed. So that it is best to give hay in nets and to mix the corn with a substance that cannot be swallowed without chewing, such as cut hay or the chaff that is thrown away at threshing time. Nervous horses are not so likely to hurry if they are fed in nose-bags and away from their neighbours.

When carrots are given they should be sliced, not cut across into rings, or a greedy horse may choke himself with a large piece. Horses enjoy licking rock salt, and when it is not available they may gnaw the walls or eat their dung.

Watering is only second in importance to feeding. All large herbivora need large quantities of water and suffer greatly if deprived of it. When horses are watered together at troughs or a stream, none should be allowed to leave until the last has drunk his fill. Nor should it be supposed that a horse has necessarily finished drinking because he raises his head from the water. No faster pace than a walk should be allowed to and from the watering place, and one man cannot attend to more than two horses at a time. Bits should be removed before watering and if saddled the girths loosened. Clear running water is best; most horses are very particular about the state of the water they drink. A constant supply is ideal although not generally practicable, but there should be access to water at least three times a day.

Watering should always take place before feeding, because if the stomach be full of undigested grain this is likely to be washed into the intestine by a large draught of water and so cause colic. It is said, also, that water after a feed of corn causes it to swell and so may rupture the stomach, but as a supply of gastric juice is always present with food this is not apparent. The idea that horses should not be watered when sweating or warm from exercise is dying out.

Grooming increases the skin circulation, removes parasites and epithelial débris, and improves the appearance of the coat. It is said to be very important; but one sees farm horses that are never touched with a brush and apparently in the pink of condition. One great advantage is that as the groom goes over the whole body, the animal's condition is noticed and no wound or injury is likely to be missed. The curry comb is for cleaning the body brush, the horse should not be touched with it. The dandy brush is for the legs, mane and tail, and for removing caked mud. The hoofs should be picked out whenever the horse is groomed even if standing on dirty ground, so that the foot is constantly examined and old septic dirt removed. Bad work on the part of the groom is usually obvious under the belly, at the pole, or the point of the hock. The legs should not be washed or the fetlock hair cut, because this lock of hair drains off wet and protects the thin skin beneath.

Clipping is a subject over which different opinions are held, so perhaps it is well to give one's reasons for advocating it. The horse's coat adapting itself to weather conditions, in the summer is thin and short, but as the cold weather approaches becomes long and thick. The working horse having an unnatural amount of exercise tires more quickly with this heavy coat, sweats profusely, and when wet is very difficult to dry, so that he may have to stand for some time in this wet coat and perhaps in the cold. Therefore, it is the custom, usually in October or November, and again about the New Year, to remove this long coat by clipping, either over the whole body or in part. Thus, the animal may be clipped "trace-high," that is, removing the coat below the level of the traces, generally leaving the legs but running the clippers along the under surface of the neck. Or again, the whole body may be clipped with the exception of the legs, or perhaps in a riding horse leaving a "saddle-patch" also.

In deciding which method to adopt one must first become acquainted with the divisional orders on the subject. If a free hand is given, I think that if a horse is standing in the open and not working hard, he should not be clipped at all, but if fairly comfortably housed and a rug is provided he is better clipped all over with the exception of the legs. If a riding horse with hairy legs, clip all over the first time but leave the legs the second. I see no advantage in leaving the "saddle-patch."

When clipped, horses have a much smarter appearance, are much more easily cleaned and so more attractive to the groom, who will take more interest in them.

Hand or machine clippers may be used, the latter saving time and labour and generally producing better work. There is no need to singe afterwards. Some animals are fidgety while being clipped, but with quietness and patience all but the most restive can be dealt with. Grooms, however, are too fond of using more forcible methods of restraint

and the commonest of these is the twitch. This is a stout stick with a loop of rope at one end. The loop is put over the upper lip and twisted tightly. The lip is liberally supplied with sensory nerves and one has only to pinch one's upper lip firmly to understand why the horse is so easily managed when the twitch is applied. That it is of use as a last resource in some cases one is prepared to admit, but it should never be made use of without consideration and in my opinion only with the consent of an officer.

Shoeing is a difficult subject to deal with in a short note but the following points are important:—

The shoe should be made to fit the foot accurately before being nailed on. Too often a badly fitting shoe is nailed on and the hoof is then cut and rasped to bring it in line with the shoe. The hoof should not be rasped above where the nails are clenched and then the less the better, nor should the frog be touched with the knife except, perhaps, to remove loose tags.

The shoes carried on the wagons and the saddles of riding horses should each fit the horse they are intended for, and before setting out on a journey one should examine them to see that they do.

By order of the A.D.M.S. of this cavalry division each ambulance horse is numbered on the hoof, and a book is kept by the shoeing smith who enters in it daily the number of each horse shod that day. From experience one recommends this plan strongly.

Exercise is of course most important. At least two hours a day are necessary, mostly walking, with some trotting on soft ground if possible. A gentle trot uphill provides plenty of muscular work and places but little strain on the legs and feet. Walk down hills. A halt, allowing the horses to graze for a few minutes, breaks the monotony and a different route each day is more interesting for both men and horses. Walk the last mile or so home so that the animals are cool on their return to the stable. The practice of passing the halter rope through the mouth should be forbidden. In fine weather horses should stand in the open air all day.

On the March.—When starting on a journey it is a wise precaution to see that the shoes are secure and that the harness is fitting properly and well put on. Carry a feed in a nose-bag. The start should be slow, a good plan is to walk the first mile or so. For long distances a gentle trot will take one a long way, and often more speedily in the end than a quicker pace that cannot be maintained without tiring the horse. "Festina lente" is a good motto for a journey. Walk down and up steep hills and the last part of the road home. Opportunities to water should be taken advantage of, and an occasional halt with a feed, slackening the girths, add greatly to the animal's power of endurance. Remembering the aphorism of that sound sportsman, Mr. Facey Romford, "men can ask for what they want, horses can't," one should

always endeavour to actually see one's horse fed and comfortable, certainly before taking food oneself.

Dismount whenever possible. One need not enlarge upon what relief the horse must feel in losing his load, even for a few minutes, but there is another reason. The most serious cases of sore back are caused by necrosis resulting from continued pressure of the saddle. That is to say, the blood supply of the saddle-bearing area is seriously interfered with by the weight of the saddle and rider. When one sees riders sitting their horses almost the whole day through without attempting to dismount it is surprising that sore-backs are not more frequent than they are.

An occasional dismounted walk uphill is a great help to the horse, especially if the rider is tired, because galls are also caused by friction when a bad or weary horseman rolls about in the saddle. A walk rests the man's riding muscles and he rides better after it.

At a halt of any time saddles should be removed and the backs rubbed to restore the circulation.

On returning to the stable the horse is watered and given a little hay to stimulate the appetite before the feed of corn.

The saddle may be loosened and left in its place for half an hour, or it may be removed at once and the skin beneath it massaged.

Drying a horse with a long coat wet with sweat is a tiring and tedious process. He may, however, be rubbed down with straw and then a rug thrown over him with an armful of straw placed on the back beneath the rug with the ends of the straws projecting over the tail. By this the horse is kept warm, and as the straw affords ventilation and warmth he can be left to dry for a time.

If exhausted, warm oatmeal gruel supplies warmth and quickly digested food. Linseed gruel is good but takes a long time to prepare.

Bandaging the legs with puttees or rope made by twisting hay prevents loss of heat from parts where large blood-vessels come near to the surface.

Harness.—Badly-fitting harness should be immediately put right. Sometimes it appears to fit badly because it is not put on properly, often the bit is drawn too high, so as to wrinkle the corner of the lip, and this should not be. The curb chain is generally too tight. And one should remember that the prominent ridge running along the spine should never be touched by the saddle, or a gall will be the result. Sometimes the D at the pommel drops and may touch the withers, producing a wound. A plain surcingle must never be put on over a rug without a pad on either side of the prominent spine just referred to, to protect it. Straw or hay pads will answer the purpose.

In draught horses, the zinc plate which fits over the neck may be too narrow. One reason why it is made of metal is that it may be kept clean, but this does not always appear to be recognized.

Condition.—Horses may be in poor condition from several causes—

some have bad grooms, others are robbed of food or worried by their neighbours. The remedies for these cases are apparent. When a horse is looking poor, the attendant will probably suggest that he has worms, which is no doubt the case. But nearly all horses harbour worms of one sort or another, and suffer far less from them than they would from the treatment often prescribed by the groom. During the late summer months one may notice about the forelegs small yellow bodies, smaller than a pin's head, each firmly attached to a hair. These are the eggs of the bot-fly. The horse takes these into mouth while licking the legs and so to the stomach, where they become fixed and grow into the bot, or larval state of the bot-fly. In the spring they pass out with the fæces, and many so-called vermifuges owe their popularity to this fact. One doubts whether the common varieties of worms found in the Army horse are likely to do much harm.

Rough or uneven molar teeth, however, often cause the animal to lose condition. If the sharp edges be rasped smooth the food is better masticated, and the improvement is often very striking. It is usually in old horses that this operation is necessary. If possible, veterinary advice should be sought before proceeding to rasp the teeth, as an unskilled farrier may do more harm than good.

Lice cause the horse a good deal of discomfort, and unless detected early and energetically treated soon spread through the stable. The first sign, generally, is that the buttocks show signs where the animal has rubbed against the stable wall, or the hair of the tail may have an untidy appearance from the same cause. By slowly stroking the hair up in the wrong direction the parasites may be seen as small, brownish bodies fixed to the skin. When these are found, the treatment is to isolate, and report to the veterinary officer, who will probably advise that the horse be clipped and dressed with a solution of nicotine in the strength of 1 to 80. The hair removed by clipping should be burnt. The nicotine solution will kill the lice but not the nits, so that three or four further washings will be necessary, one every four or five days. One should, if possible, choose what a washerwoman would call a "good drying day" for this and exercise afterwards until dry.

But if on examination one finds bare patches of skin and hair which comes out on rubbing with the finger, the case should be isolated and reported immediately to the veterinary officer as it may be mange, and this is a serious matter in an army.

It is usually the duty of the orderly officer to visit the stables at night. If he is not interested in horses this is often a farce. Each horse should be looked at, and this is possible without disturbing those that are lying. Rugs may be slipping from some, the surcingle too tight or without a pad beneath it on others, and on a close night the stable may need ventilation. If the transport officer is fond of horses and goes round

every night himself, he will find that this night visit will soon develop into a pleasure and a duty he will be sorry to miss.

In concluding these scattered and, I fear, ill-prepared notes, I cannot do better than quote from Whyte-Melville's excellent "Riding Recollections," where he says "of all our relations with the dumb creation, there is none in which a man has so entirely the best of it as the one-sided partnership that exists between horse and rider."

A METHOD OF TREATMENT OF "SHELL SHOCK."

By Captain E. T. C. MILLIGAN, M.D., B.S.Melb.
Royal Army Medical Corps.

A well-known method of treatment of hysteria has been applied at this Casualty Clearing Station to selected cases of what is now diagnosed as "shell shock." The results of this treatment have been so satisfactory that I desire to give some account of the details of the same in this brief note.

Nature of Cases Treated.

The cases treated were those who "could not speak," "could not hear," "could neither speak nor hear"; cases of loss of memory; cases obsessed by the memory picture of recent terrible experience, their minds being occupied, to the exclusion of all other things, by the bursting of shells, in the trench or during the attack.

Other cases which have been treated are those of loss of function, partial or complete, in one or more limbs; of inability to walk, and of neuromimetic deformity of limbs.

We have endeavoured to select for treatment only cases of genuine hysteria and of conscious fraud.

Malingerers with mimicry so close and acting so consistent that it was difficult to discriminate them from genuine hysteria, respond more easily to the method, though in a different manner.

Cases Excluded from this Treatment.

Care has been taken to exclude all cases suffering from discoverable organic lesions of the special sense organs, the central and peripheral nervous system, and organic lesions of the above accentuated by hysteria. The underlying organic lesions in these cases must first be treated.

It is not the purpose of this note to classify the many different conditions caused by "shell shock," nor to suggest the pathological condition, psychic or physical, underlying them.

Treatment.

It is well known that during chloroform administration there is a stage before the involuntary struggling stage when a patient is highly

susceptible to suggestion. It is while the patient is in this stage that suitable suggestion and stimulation should be used. The treatment must be conducted in a quiet room apart from other patients, chloroform is slowly administered and suggestion carried out by the anæsthetist when the patient has reached the required stage.

In cases of loss of memory and cases where the memory of past experience is blotted out, and replaced by the mental picture of recent terrifying incidents, the past life of the soldier can often be recalled by suggesting to him some person or object of his affections, as his wife, his child, or his mother. Mention of his home life, and country; his regiment and occupation has proved effective in restoring the chain of past experience.

Mutism is treated by the insistent asking of suitable questions in the suggestible stage and cutaneous stimulation is found of use.

Loss of hearing responds to the same methods.

Hysterical attitudes of limbs are changed to opposite attitudes and fixed there firmly with bandages—thus extension is changed to extreme flexion.

Loss of function of limbs is overcome by continuing to give passive movement together with suggestion as the patient is regaining full consciousness.

In obstinate cases complete anæsthesia is produced and the patient is immediately allowed to recover from the anæsthetic. As he emerges he is again in an impressionable state and this state has been used for suggestion with success where the first efforts of the operator were not successful.

In all types of cases, suggestion should be continued till the patient has fully recovered consciousness.

When quite rational the man is assured of his cure, promised a rest, given morphia, and allowed to enjoy a much needed sleep.

The after treatment consists in prolonged rest and change of surroundings, even although the most obvious symptom of the mischief, for it is a symptom only, has been remedied.

All cases should be treated at the earliest possible moment. Chloroform is better than other general anæsthetics for this purpose because it produces definite stages of anæsthesia which can be readily prolonged as required. Cases which have been cured by abnormal experiences—such as an abdominal operation, or a shipwreck—would probably have been cured earlier by suggestion under chloroform.

TWO CASES OF PENETRATING WOUNDS OF THE ABDOMEN INVOLVING THE INFERIOR VENA CAVA.

By Captain D. C. TAYLOR, F.R.C.S.
Royal Army Medical Corps.

The two following cases of penetrating wounds of the abdomen, complicated by tearing of the inferior vena cava, have recently come under my care:—

Case 1.—Private M., aged 20, admitted to clearing station twelve hours after being hit by a piece of high explosive shell. Wound of entrance tenth right rib in posterior axillary line, no exit wound. Patient was pale, and had marked abdominal pain, tenderness, and rigidity. No vomiting. Pulse 100. Respiration 28.

Laparotomy.—Warm ether vapour. Axillary saline. Incision through right rectus, fair amount of free blood in peritoneum. Right lobe of liver penetrated, but not bleeding. A single tear two inches long in the greater curvature of stomach, extending on the anterior wall near pyloric end, was found and sutured. The stomach was empty, and no contents had been extruded. No lesion of bowel was discovered. A small retro-peritoneal hæmatoma was noticed at, and on the right side of the base of the mesentery of the small gut. A rubber tube was passed under the surface of the liver, and the rest of the incision closed in layers. Pulse at end of operation 120. The pulse began to fail six hours later, and he became very blanched; he died eight hours after operation.

Autopsy.—No fresh lesion in gastro-intestinal tract was discovered. There was an enormous retro-peritoneal hæmatoma on the posterior abdominal wall, but little or no fresh bleeding into peritoneal cavity. An oval hole, of about the area of a threepenny-piece, was found in the anterior wall of the inferior vena cava just below the entry of the right renal vein. Careful search failed to find the missile.

Case 2.—Rifleman R., aged 40, admitted to clearing station three and a half hours after being hit by a fragment from a bomb. Entrance wound one inch to right and half an inch above the umbilicus. A small tag of omentum was extruded. No exit wound. Patient pale, pulse 120, abdomen very rigid and tender, had vomited four times.

Laparotomy.—Warm ether, axillary saline four hours after injury, incision through right rectus, excising track of missile, much free blood in peritoneum. Missile had passed through gastro-colic omentum, just missing the colon; two veins were bleeding; ligated. Two large tears in front loop of jejunum were found, one at the mesentery border, with a small tear of the mesentery, the other at the free border of the bowel, immediately opposite. Both tears were sutured. Much bleeding from the posterior abdominal wall on the right side. The intestines were packed back, and a hole was found in the posterior peritoneum, just outside the

line of the inferior vena cava, and a considerable retroperitoneal hæmatoma. Posterior peritoneum was slit up with scissors, when furious bleeding took place from a hole in the anterior wall of the inferior vena cava, at and below the entrance of the right renal vein. The tear was longitudinal, and three-quarters of an inch long. Bleeding was checked by placing the tip of the left forefinger in the hole in the vessel. Attempts were made to control the bleeding by compressing the vessel above and below, but failed, owing to proximity of the renal vein. A pair of artery forceps was placed on the front of the cava just above the wound to produce a pleating effect, and then a series of six other artery forceps were applied from above down, effectually closing the hole, leaving the lumen of the vessel patent, but narrowed. The missile was not found. The omentum was then packed around the bodies of the forceps. The abdominal incision was rapidly closed with deep salmon-gut sutures, taking up all the layers; the handles of the artery forceps were left protruding through a gap in the middle of the incision. The pulse at the beginning of the operation was 80, and blood-pressure 140; at the end the pulse was 120, and blood-pressure 80.

First day after patient surprisingly fit; pulse 112; vomiting at frequent intervals. Rectal salines given. Urine normal.

Second day vomiting stopped; taking fluids well; pulse 80. Bowels acted naturally, no abdominal distension, no discharge from wound, urine normal.

Fourth day warm chloroform and ether mixture given, and stitches above and below forceps removed and muscles separated. Adhesions had formed a good firm track down to points of forceps. The forceps were then removed one by one, and no bleeding took place until the last pair was removed; this bleeding was trivial in amount, and easily controlled with a gauze plug. Two days later the gauze plug was removed without any further bleeding. The patient did not vomit after the second anæsthetic.

The patient was evacuated to the base on the tenth day, and a month from the injury I hear he is doing well in England.

I have heard of other cases of wounds involving the inferior cava being brought to clearing stations, but the cases I believe have all ended fatally. The second of my two cases shows that it may be possible to save some of these cases by using forci-pressure, or, possibly, suture in cases where the bleeding can be controlled while the suture is inserted. The reason that these cases do not bleed to death immediately is that the wounds in the posterior peritoneum and the cava are not, or do not remain, directly superimposed.

I am much indebted to Lieutenant-Colonel Langstaff for permission to publish these notes, and also to Colonel H. M. Rigby for his advice in the after-treatment of the second case.

TRAUMATIC ANEURYSM.
A SERIES OF EIGHT CASES FROM GENERAL HOSPITAL, EGYPT.

By Captain A. W. BOURNE.
Royal Army Medical Corps.

Case 1.—Traumatic Aneurysm of Posterior Tibial Artery.

The patient, Pte. H., was admitted to hospital on May 11, about a week after being wounded. He presented a gunshot wound of the upper third of the right leg—the bullet having passed horizontally through the fleshy part of the calf. The entrance and exit wounds were healed. The calf was occupied by a hard diffuse swelling, which was very tender, causing spontaneous pain, and compelled the patient to keep the knee slightly flexed and rigid. There was no redness or œdema of the skin, nor could any pulsation be detected. The anterior tibial artery could be felt, but it was not possible to detect pulsation in the posterior tibial artery. Except for the fact that the pulse and temperature were normal, the clinical condition closely resembled a deep abscess of the leg.

Operation, May 13.—In view of the uncertainty in diagnosis a small exploratory incision over the swelling was made, and sinus forceps introduced, followed by a gush of red arterial blood, which was easily stopped by a small plug of gauze. As the swelling extended well up to the popliteal space, it was considered that ligature of the posterior tibial artery would be exceedingly difficult, if not impossible, on account of the anatomical disturbance and infiltration of the tissues by blood, even if all bleeding was checked by the tourniquet. Therefore the popliteal artery was tied by the ordinary route to the upper part of its course. A long incision was then made over the whole length of the swelling, and a large ragged cavity was opened up, partially filled with old clot. The cavity of the aneurysm, after the removal of clot, was found to extend from the lower border of popliteus muscle to the middle of the leg, and was mainly situated between the soleus and deep muscles. Having cleaned and explored the cavity, some bleeding was noted from the upper extremity of the sac, and this was readily caught and ligatured. The wound was sewn up, except for a small drain placed in for twenty-four hours on account of some general venous oozing.

Subsequent Progress.—For some days after operation the condition of the leg and foot was critical, as the circulation was barely maintained. The foot remained cold, and a small patch of gangrene occurred on the pulp of one toe, but this remained localized, and the circulation of the limb was gradually restored. The wounds healed well and the pain and stiffness disappeared.

Note.—The chief difficulty and danger of this case was the impossibility of ligaturing the artery which was the seat of the injury, requiring the ligature of a parent proximal trunk (the popliteal). Always a hazardous

procedure from the point of view of subsequent vitality of the leg, it was especially dangerous in a case where collateral circulation was already damaged by wide extravasation of blood. An alternative procedure would have been the application of a tourniquet, and the opening of the sac without previous proximal ligature, followed by securing the wounded artery from inside the sac. This was considered, but not carried out, because it was anticipated that to find the proximal end of the artery high up towards the popliteal space would have been an extremely difficult and lengthy process, involving a deep dissection in tissues whose wound anatomy could scarcely be recognized.

However, it is admitted that ligature of the popliteal artery is unsatisfactory and dangerous, and that the ideal operation is to secure the vessel from the sac. But in this region of all others in the body this method is liable to be attended by great difficulties of dissection on account of the great depth of the upper part of the vessel and its comparative smallness of calibre.

Therefore, in reviewing this case, one recognizes that a preferable operation would have been the application of a tourniquet as suggested above, but ligature of the popliteal artery only if it were found impossible to define and secure the proximal and distal ends of the posterior tibial.

CASE 2.—TRAUMATIC ANEURYSM OF POSTERIOR TIBIAL ARTERY.

Corpl. C., Australian Light Horse, was admitted to hospital on May 24, about a week after being hit. He complained of swelling and pain in the right calf, and small entrance and exit bullet wounds, the one over the subcutaneous border of the tibia at the junction of the middle and upper thirds, the other behind the leg in the middle line, and at the same level. There was a discharge of sanious pus from the anterior wound, and a little pure blood leaked away from the posterior wound. The calf was diffusely swollen, firm and tender, but there was no pulsation of the swelling, nor could the posterior pulse be felt, but the pulse of the anterior tibial artery was easily detected. The foot was warm, and there was no engorgement of the veins of the foot. The bullet had traversed the tibia, and though splintering it, had not produced a complete breach of continuity.

Operation, May 27.—An incision was made, as for ligature of the posterior tibial artery, in its middle third. The artery was found torn through in the track of the bullet, and collapsed below the lesion. The tissues were infiltrated with blood, and there was considerable splintering of the tibia. There was no definite sac, but a large ragged cavity filled with blood clot. As this was removed there was considerable hæmorrhage from oozing.

As the upper end of the artery could not be found immediately above the lesion, the wound was continued upwards to a point below the bifurcation of the popliteal artery, where a ligature was applied to the

posterior tibial artery. As the wound was infected, free drainage was provided.

On the second day after operation, the wound became acutely septic, and stitches were released. There was high rise of temperature, and the vitality of the foot became critical. On June 2 gangrene of the foot supervened, and the limb was amputated at the knee joint without the stitching of flaps. The patient's condition slowly improved, and later flaps were fashioned and sutured over the femur, healing by first intention.

Note.—This case might be called a septic arterial hæmatoma, for several of the features of true aneurism were lacking. The difficulty and danger lay in the septic state of the leg, rendering any dissection to expose an artery a hazardous procedure. The gangrene of the foot was probably due to interference of the circulation by the acute œdema and swelling of the leg following the operation.

CASE 3.—TRAUMATIC ANEURYSM OF FEMORAL ARTERY IN HUNTER'S CANAL.

Lance-Cpl. P., Manchester Regiment, was admitted to hospital on June 15, with a pulsating tumour at the lower third of Hunter's canal, about 2½ inches in diameter, and projecting slightly above the general level of the thigh. The entrance wound was small and healed and situated on the swelling, while the exit wound, also small and healed, was found on the outer and posterior aspect of the thigh at the same level. The pulsation was expansile, with a thrill, and a bruit conducted for a short distance up and down the thigh. The veins were not distended, the foot was warm, and there was a small pulse felt in the dorsalis pedis. There were no neuralgic pains.

Operation, June 17.—A long incision of six inches was made over Hunter's canal, having the tumour at its centre. The femoral artery was identified and clamped by a rubber clamp two inches above the aneurysm, and also immediately below the tumour, at the point where the femoral artery was becoming popliteal. The (anatomy of the) sac was next explored, and dissection showed it to be partly in the substance of the sartorius muscle. When the sac had been dissected out, and thoroughly good exposure obtained, it was opened, and in spite of the clamps on the vessel, there was very free bleeding. However, it was found to escape from a small rounded hole in the floor of the sac which led directly into the femoral artery. This was clipped and bleeding ceased. The artery was then ligatured immediately above and below the lesion in its wall, and the clamps were removed. Even then, however, there was hæmorrhage on removing the clip securing the hole in the artery, and not until this was ligatured was the wound dry. There was considerable loss of blood, and consequently some shock and temporary anæmia. No drain was inserted, and the wound healed by first intention. The foot

remained warm, and the patient made a complete recovery without any disability.

Note.—The point arising for discussion out of this case is whether or not some reconstruction arteriorrhaphy might not have been performed here, in view of the very small and circumscribed hole in the femoral artery. Further, the sac was adventitious, and the artery wall had no part in its constitution.

However, there were four difficulties which prevented the conservative treatment of the vessel wall. Firstly, the tissue of the vessel wall surrounding the lesion was friable, and would not hold firmly a trial suture.

Secondly, there were not to hand suitable small curved needles necessary for such fine work. Probably the vessel wall would have held thin silk introduced by a suitable needle. Thirdly, the difficulty of hæmorrhage from the lesion was great, and it was impossible to secure a dry area of operation for the introduction of the necessary sutures, even after clamping of the vessel close to the lesion, above and below. Fourthly, the general condition of the patient owing to hæmorrhage precluded any unnecessary lengthening of the operation.

Case 4.—Traumatic Arterio-Venous Aneurysm of Femoral Vessels in Hunter's Canal.

Pte. W. was admitted to hospital on June 18, with a small, slightly raised pulsating swelling, about two inches in diameter. Pulsation was most obvious over the tumour, but it could be detected extending backwards into the hamstrings. A thrill was felt for two inches above and below the swelling, and also extending horizontally. A loud bruit was heard, conducted upwards to the groin, and downwards to the middle of the calf. The pulse was present in both tibial arteries, but not so marked as on the sound side. The veins of the leg and foot were enlarged, but not very markedly. There was no œdema, no referred neuralgic pains.

Operation, July 28.—A long incision of seven inches was made along Hunter's canal, commencing well above the tumour. The artery was exposed, and a rubber-covered clamp applied. The sac was then dissected out, and found to be lying under cover of the sartorius, in the substance of vastus internus, extending slightly backwards towards the posterior aspect of the femur. The inferior limit of the sac reached to the termination of the femoral artery, therefore the distal arterial ligature was temporarily applied around the highest part of the popliteal artery, as near to the sac as possible. Further cleaning and examination of the sac was carried out, and, on opening it there was considerable bleeding which was soon controlled by clipping a small hole in the bottom of the sac. Having checked the bleeding the exact anatomy of the injured vessels was explored, and it was found that the femoral artery had a large gutter-

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shaped hole, while the vein adherent to the artery exhibited an irregular laceration, both vessels opening into the sac.

A ligature was applied to the artery immediately above and below the lesion in the vessel, but ligature of the vein proved a difficult matter, as the vessel wall was friable and failed to hold the catgut, and several ligatures were tied before venous oozing was finally arrested.

The sartorius which had been divided was sutured, and the wound completely closed. Healing was by first intention, the foot remained warm, and there was no functional disability.

CASE 5.—TRAUMATIC ANEURYSM OF THE BRACHIAL ARTERY.

Capt. S. was admitted to hospital in August, complaining chiefly of considerable neuralgic pains in the forearm and hand, and almost complete inability to move the fingers after a gunshot wound of the left arm in its middle third.

Examination showed a small almost healed bullet wound at the inner edge of the biceps in the middle of the arm, and a similar wound posteriorly, slightly internal to the middle line. A diffuse hard fullness occupied the inner aspect of the arm between the two bullet wounds. No pulsation was visible, but it was just palpable. The brawny swelling extended down to the bend of the elbow, and on to the inner side of the forearm, but here there was no pulsation. No thrill was felt, but a bruit was conducted down the radial as far as the wrist. Pulsation in the radial was good, but not so well marked as on the sound side. The veins of the hand and forearm were not congested. There was almost complete median nerve paralysis and anæsthesia.

The operation was delayed a few days to allow complete healing of the wounds, and during this time there was a gradual but slight increase in the swelling and pulsation.

Operation, September 9.—The brachial artery was exposed above the sac and clamped, but the tissues were so œdematous below the sac that the vessel was not dissected out in this region.

The sac was defined and opened after the median nerve had been drawn aside. Bleeding was free, but easily stopped by packing while the clot was turned out and the interior of the sac explored for the bleeding point. This was found to be a small hole in the artery, and ligatures were applied immediately above and below the lesion. Even after such control of the vessel, hæmorrhage was not arrested, for blood escaped from a branch given off at the level of the hole in the vessel, between the two ligatures. The sac was found to extend upwards and outwards in the biceps, and downwards along the course of the brachial artery. There was no injury of the venal cavities. A few small incisions were made to relieve the œdema of the forearm. The median nerve was contused, and its tissue infiltrated with clot, while the inner edge had been very slightly torn. The nerve was carefully freed from all sur-

rounding clot, and the wound closed without drainage. Subsequent progress was satisfactory, but slow. Healing was by first intention, but the neuralgia continued to be troublesome, and only slowly improved, while no improvement could be detected in the movements of the fingers for the three weeks patient remained in this hospital.

CASE 6.—TRAUMATIC ANEURYSM OF THE AXILLARY ARTERY.

Pte. D. was admitted to hospital on May 30, complaining of inability to "bend the elbow," pain in the forearm and hand, and a "lump under the collar bone."

Examination showed a diffuse pulsating swelling lying below the outer half of the left clavicle beneath the pectoralis major, and extending slightly into the axilla. There was a small septic bullet wound just below the swelling, and another behind the shoulder just below the level of the spine of the scapula. Both wounds were shallow and superficially infected. The left pulse was present, but smaller than on the sound side. There were a thrill and a loud bruit. The veins were not enlarged. Inability to bend the elbow was due to paralysis of the biceps; the finger movements were feeble, and the patient was much troubled by pain along the inner aspect of the arm and forearm. It had been decided to delay operation until the bullet wounds were quite healed, but, unfortunately, there was a definite increase in size in the tumour, and greater pain after the first twenty-four hours, and in view of this the operation was performed immediately.

Operation, June 1.—The first step was ligature of the subclavican artery in its third stage by the usual incision. An incision was then made over the tumour, as for ligature of the first part of the axillary artery, but continued outwards and downwards on to the arm, following the course of the artery. The axillary artery was defined immediately below the tumour and ligatured. The vessels being thus controlled by ligature, the pectoralis major muscle was divided transversely as it crossed the tumour, and in this way excellent exposure was obtained. The sac was now freely opened in its whole length by an incision parallel to the clavicle. The hæmorrhage was furious. A thick pad was thrust into the sac and drawn slowly outwards along the bottom of the sac in order to locate the origin of the bleeding. It was by this means identified as coming from a small hole in the outer portion of the sac, which appeared to be the origin of the subscapular artery. This was clipped and ligatured, but bleeding still continued from a ragged lesion of the axillary vein. Great difficulty was encountered in arresting the venous hæmorrhage and, finally, it was found necessary to leave three artery clips in situ, owing to the impossibility of ligaturing the friable tissue. The pectoralis muscle was sutured, and the wound drained from its lowest part, in the axilla.

The wound progressed well for six days, after which suppuration

occurred and involved the whole wound, requiring further drainage. Three weeks after operation a small venous hæmorrhage from the inner part of the wound caused some anxiety, but it was arrested by packing. In five weeks suppuration had ceased and the wound healed. The neuralgic pains slowly cleared up, but the biceps remained paralysed, and there was limitation of abduction of the arm. No pulse returned at the wrist, but the hand was always warm. The subclavian wound healed by first intention.

Note.—The feature of this case was the extraordinarily brisk hæmorrhage that took place on opening the sac, after ligature above and below. Further experience, however, has shown that such bleeding is to be expected in this region, however close to the sac the ligatures are applied, so free is the arterial anastomosis.

Case 7.—Traumatic Aneurysm of First Part of the Popliteal Artery.

Pte. M. was admitted to hospital on June 6 with a diffuse pulsating swelling of the lower third of the thigh on the inner and posterior aspect. The entrance bullet wound was situated just over the lowest extremity of Hunter's canal, small and quite healed, but the exit wound was larger, and freely discharging pus, lying on the outer aspect of the limb in front of the biceps tendon. The veins were not engorged; there was no pulse in the dorsalis pedis, but the foot was warm.

Operation, June 9.—Incision along the lower third of Hunter's canal, and continued along the inner and posterior aspect of the knee. The femoral artery was traced to the sac, and ligatured where it passed under the adductor magnus tendon, and the popliteal artery was tied immediately below the sac. The sac was found to be lying on the posterior aspect of the femur immediately above the condyles. When the aneurysm was opened there was a gush of venous blood, which was arrested after several clips and ligatures had been applied. The usual difficulty was again experienced in checking bleeding from the wounded vein, owing to the large and ragged nature of the hole, and the friability of the vessel wall.

The wound was drained, and considerable suppuration followed, but pus chiefly escaped from the exit bullet wound. The patient had later erysipelas of the forehead and also of the thigh, but eventually recovered. The functional result was good.

Case 8.—Traumatic Aneurysm of the Abnormal Superficial Ulnar Cavity.

Pte. C. was admitted to hospital on August 17 complaining of pain in the region of the elbow, and inability to extend fully the elbow joint. The forearm was held partially flexed and in semi-pronation. There was a small healed punctured bullet wound one inch below the bend of the elbow, and slightly to the outer side of the middle line, and a similar

healed exit wound one and a half inches below the internal epi-condyle. A small diffuse swelling chiefly on the inner side immediately below the bend of the elbow. Pulsation was palpable in a localized small area on the inner side of the swelling. There was no thrill, but a high-pitched bruit not heard beyond the limits of the tumour. The radial pulse was, if anything, fuller on the affected than the sound side. No change in the veins and no neuralgia pains.

Operation, August 19.—The incision was commenced in the line of the brachial artery, two inches above its bifurcation, following its course downwards and then curving inwards over the swelling. The artery was clamped above the bifurcation. As it was thought that the aneurysm arose from the ulnar artery, an incision and dissection were then made to expose the ulnar artery in its upper third, directly below the aneurysm. However, in spite of prolonged search, the ordinary ulnar artery running inwards to join the ulnar nerve could not be found, and the ulnar nerve coursed down the forearm unaccompanied by any artery of recognizable size. This absence of the normal ulnar artery was afterwards explained by finding a large superficial ulnar artery which probably took the place of the deep vessel. The sac was then opened and the clot turned out, but no bleeding took place until the clamp was released from the brachial artery, and this hæmorrhage escaped from a wound of the superficial ulnar artery, which passed over the sac. The sac was small, and superficial to the origins of the ulnar and radial arteries. A ligature was placed around the brachial artery above the bifurcation, and also around the superficial ulnar artery above and below the lesion.

The wound was closed and healed by first intention. The hand remained warm and there was a complete recovery.

A ligature was applied to the brachial artery on account of the uncertainty felt as to whether the deep ulnar artery had also been wounded, but probably it was not necessary.

REMARKS ON A CASE OF SHRAPNEL WOUND OF THE POSTERIOR WALL OF THE PERICARDIUM WITH AN ACCOUNT OF THE OPERATION FOR THE REMOVAL OF THE MISSILE.

By Honorary Major R. SCOT SKIRVING, M.B.

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The management of injuries to the heart and pericardium is now set forth in all treatises on surgery, but the actual number of recorded cases is not, in the aggregate, very great. I hope, therefore, I am justified in publishing the following example, which shows some of the difficulties

of X-ray diagnosis, as well as anatomical and physiological risks in operative interference with this part of the body.

The patient, a strong, wholesome-looking young soldier, aged 22, was wounded, somewhere in France, on October 11, 1915. He was hit under the left axilla about the posterior axillary line. The missile travelled obliquely through his lung and there was no wound of exit. He suffered much from shock, remained practically unconscious for three days, and spat blood profusely for over a week. During that period I gather that the physical signs of pericarditis were present. He was sent to England on October 27, and after periods of rest in several hospitals he was ordered back to his regiment. It was then seen that he was quite unfit for duty because of his shortness of breath on exertion, and the presence of deep-seated pain in his chest. Under these circumstances, he came under my care at the Queen Alexandra Military Hospital (Extension) on February 7, 1916. He had the above-mentioned complaints, and stated that if he walked briskly or attempted to go upstairs "he was brought up all standing."

On examination, the scar of an irregular lacerated wound in the left axilla was seen. It had soundly healed and need not detain us further. His general health was excellent, and he had no physical abnormality other than those connected with his heart and breathing. The lungs presented no pathological change demonstrable by physical examination, except that, owing to his former occupation as a coal-miner, the X-ray shadows in the pulmonary area were considered darker than usual. As to his heart, his pulse was small and rather soft, always fast, usually over 100 per minute, and occasionally a beat was missed. The heart dullness was not outside the normal limits, nor was the apex beat. The first sound in the mitral area was replaced by a soft blowing systolic murmur, not specially conducted into the axilla. I did not like to make him actively exert himself for purposes of comparison, still, on the whole, the murmur was probably loudest when the patient was at rest.

There was very marked reduplication of the second sound, especially in the pulmonary area. No pericardial friction was now to be heard.

The X-ray examination showed a foreign body situated apparently at or about the upper reflection of the pericardium, to the left of the middle line, posteriorly. This object, on the screen, could be seen to move—probably with the heart's movements—but some of those who witnessed this strange sight thought the excursions were slower than those of the heart itself. Possibly the movements were of both cardiac and pulmonary origin, for it seemed to move vertically with the respiratory and laterally with the cardial excursions. Also it rotated on its vertical axis, as if one part was more fixed than the other. In these examinations I had the assistance of the special skill of Mr. Reid of St. Thomas's Hospital, as well as that of Mr. Henry and Mr. Pooley of Queen Alexandra Hospital, also expert and experienced radio-

To illustrate "Remarks on a Case of Shrapnel Wound of the Posterior Wall of the Pericardium, with an account of the Operation for the Removal of the Missile," by R. Scot Skirving, A.A.M.C., Hon. Major.

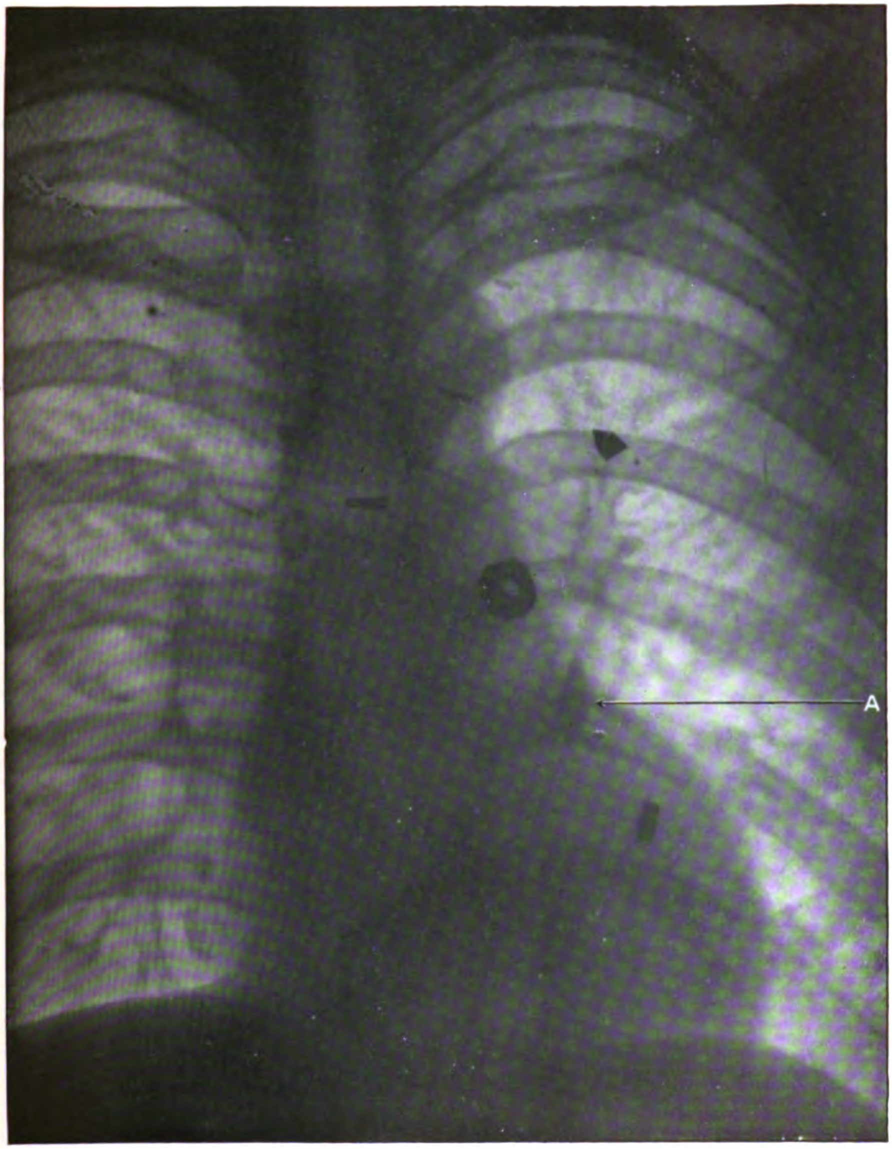

Plate I.—This plate shows the antero-posterior view of the chest, in which the foreign body lying with its sharp edge end on, looks rather like a rifle bullet. All the other marks seen are merely metal objects placed on the skin as landmarks.

graphers—to all of whom my thanks are due. Any operation on this case would have been out of the question without the knowledge gained from specially capable radiographers using very fine instruments. The photographs illustrating this paper are also their work.

The final deduction from the physical and radiographic examinations was that a piece of metal, probably a bit of shrapnel casing, had gone obliquely through the left lung, perforated the pericardium from behind, at its upper reflection, and was now imbedded, partly within the sac, partly without, lying upon or between the pulmonary veins. The risks of any effort to remove it were explained to the patient, also the chance of failure, and the possibility that even its successful removal might fail to remove his breathlessness and pain. He, very pluckily, decided in favour of the operation, on the ground that neither delay nor rest had done him any good, and that he was incapable of earning a living or, indeed, of any sustained exertion.

I accordingly operated on March 21, 1916; Colonels Pilcher and James, with Lieutenant Lock, assisting me. Major Starling, F.R.S., was present, and gave me valuable advice regarding the manipulation of the living heart, a matter with which his researches in cardiac physiology in animals had made him familiar.

There are various ways of fully exposing the pericardium, but the method used in this case was found thoroughly satisfactory. It gave most ample access.

There are a few practical details, not dwelt upon in textbooks, that I think worth mentioning. An incision was made from the centre of the sternum at the level of the 6th costal cartilage, following the line of that structure outwards and downwards to its union with its rib. This incision should be bellied downwards to demonstrate the lateral bridge joining the 6th to the 7th cartilage. The soft parts were now suitably retracted and the cartilage laid bare. The pleura lies closely below the outer part, so the separation of the cartilage should begin at its inner end which lies over the "triangle of safety,"[1] where the pleura does not reach.

The perichondrium is difficult to separate on the external aspect of the cartilage, but it is happily easier to do so on the internal, where the risk of wounding the pleura is a very real one. I cut the cartilage at its inner end and at its lateral union with the seventh cartilage, using the point of the scalpel, carefully avoiding any sudden plunge of the knife through the cheese-like cartilage. After removal of the whole of the

[1] "The triangle of safety" is the term which has been applied to that little area of pericardium which is normally not covered by the pleura. Internally, its base lies between the 5th and 7th chondro-sternal joints, and the root of the xiphoid cartilage, while the apex of the space is about 2½ inches out in the 5th interspace.

sixth cartilage, the fan-like triangularis sterni muscle come into view. It was divided, and the internal mammary vessels dealt with. I cut the artery, and tied both ends. It was very small, and gave me no trouble.

The pleura now was clearly recognized, and the presenting part pushed upwards and outwards with gauze. A vertical incision rather to the left of the mid-sternum was then made to the level of the second rib, and a little later the skin incisions were completed, by a third cut outwards and nearly horizontal for about 2½ or 3 inches. This marked out an irregularly shaped box-lid flap.

The periosteal and other tissues covering the sternum were pushed outwards with Farabœuf's rugine, carrying this clearance beyond the insets of the cartilages of the 5th, 4th and 3rd ribs, which were carefully cut through vertically.

I dare say it would be quite a neat plan to divide them in such a V-shaped way that on replacement a piece of the outer end would dovetail into the corresponding aperture in the inner fixed portion. I now raised this whole flap of cartilage, muscle and skin, at the same time gently stripping the underlying pleura off its inner surface as far back as was necessary. The flap so raised could be held well up, and I did not find it necessary to crack the cartilages at their outer extremities.

One could now see the dark obliquely placed edge of the lung like a shadow, about 1½ inches external to the left side of the sternum, rising and falling under the thin veil of the pleura, which still covered the upper part of the pericardium. Colonel Pilcher wisely reminded me at this stage that the pleura was here still in situ, hiding its actual reflection under cover of the sternum—a most timely warning, for one is apt to forget that the lung itself does not overlap the pericardium to the extent its investing pleura does so. It is, indeed, very easy to wound the pleura in this operation, although doing so need not make one unduly sad. However, I managed to sweep it safely from below upwards and outwards. It came easily from under the sternum and was pushed, uninjured, well out of the way. The pericardium was now fully exposed. An opening in it was made, and it was seen that the cavity was largely occupied by soft sticky blood-stained adhesions. This, in a way, was hopeful, as it suggested that the metal was probably within the sac. The pericardium was now slit nearly throughout its whole extent from above downwards. The adhesions, which were many, were fortunately soft, and I swept them all asunder with my finger without difficulty or any bleeding to signify.

On passing my hand behind the heart up to the base, posteriorly, I felt a hard substance embedded in soft cicatricial tissue. Professor Starling advised me now to give the heart little spells, by withdrawing my fingers from within the sac. This is quite an important point, for although the heart will stand quite a lot of handling, including turning it out of the pericardium, as long as you avoid actually kinking its base or

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PLATE II.—This plate shows a lateral view of the chest, and the lozenge-shaped appearance of the missile is plainly visible. The other objects on the surface are only landmarks.

keeping your hands touching it for too long at a time, yet it needs a rest from mechanical stimulation at short intervals. The value of these intermissions was specially noticed by the anæsthetist at this period of operation. I soon was made happy by scraping the hard mass with my finger and feeling a sharp point of metal against it. With a curved blunt dissector I began to gently free it from the embrace of the posterior wall of the pericardium. About two-thirds of the whole mass seemed to lie without that structure, and rested, as I thought, on, or between, the pulmonary veins—not a comfortable neighbourhood. It was really quite a thrilling sight to see the heart heaving and writhing before one's eyes like a squirming hairless reptile, and this effect was increased by the thought that, perhaps, when I had actually freed the metal, a fatal gush of blood might follow its delivery.

Photograph of missile, actual size.

However, all went well; I got it free, and brought it out of the body without any bleeding worth bothering about. I knew of no means worth trying to prevent the pericardial adhesions reforming. I can only hope that the removal of the exciting cause may have a quieting effect on their growth. The pericardium was sewed up with catgut—using Halsted's sutures, and taking great care to avert the lips of the incision so as to leave only a clear serous surface within. The displaced pleura was then encouraged to take up its normal position. The flap, containing skin, muscle and cartilage, was allowed to fall back into its proper place, the cartilages anchored with stout catgut stitches, and the periosteal tissues over-sewed at the points of section. The edges of the incisions were closed in the usual way without any drainage. It is, perhaps, worth while saying that I kept in place the dressing of gauze and wool pads with strips of adhesive plaster; then, to keep the pectoral muscles quiet, the left arm was laid alongside the body and fastened there by a broad flannel binder, embracing it and the chest, leaving the right arm free. The patient was nursed throughout in the semi-recumbent position. These points are of importance, because the union of cut cartilage is unsatisfactory, and by immobilizing the arm the fixation of the divided ends by suture and over-sewing was given a better chance to make a fairly firm join.

Regarding anæsthesia, in cases like this, in which the pleura is likely to be opened, the choice of anæsthetic and the method of its administration are important questions. With this case, I had the kind help of Mr. Rood, of University College Hospital, who gave the anæsthetic, ether and oxygen in varying proportions, through a tracheal tube connected with the usual apparatus for insufflation (Meltzer's method). This was employed mainly in view of any possible accidental opening of the pleura. If I had failed to get the metal out through the pericardial route, I intended to open the pleura and seek for it in the anterior *cul-de-sac* of that cavity. This would have meant some collapse of the lung. My reading and experience of pleural operations (chiefly in hydatid disease) leads me to believe that this event is not by any means so serious a matter as had been supposed. To begin with, the free collapse of the lung needs more than merely opening the pleura, for the stickiness of the layers keeps them together, and so maintains the condition necessary to prevent any extensive collapse. Moreover, pleural adhesions in adults are not uncommon and also hinder general collapse of the lung. Again, granting that partial collapse does take place, it is not an unmixed evil in cases like mine, for it diminishes the excursions of the heart's movements, and makes more room in the chest manipulations of or about the heart.

However, admitting all this, one does not willingly wish to open the pleura in this operation, and if by accident one does so it makes one's mind easier to have the intra-tracheal method of giving anæsthesia in action to keep the lungs inflated, and maintain normal pulmonary ventilation.

Moreover, by keeping the lungs distended and the pleura in its normal state, one is less likely to wound it accidentally when turning back the big flap and sweeping the surface of the pericardium of its overlying reflexion of pleura, which, recollect, is very thin and fragile.

My judgment, therefore, on this matter of tracheal anæsthesia, is to try and obtain the added comfort (I refer to the operator, not the patient) of this apparatus, and a competent man to use it. If, however, these "counsels of perfection" be not obtainable, I see no reason why one should hang back from doing the operation without them if the necessities of the case demand it.

The after-history of this case has been, happily, quite uneventful. There was hardly any post-operative shock, no temperature, but the former quick pulse persisted, nay, rose to 126 per minute, and lasted for several days. By the tenth morning it had fallen to 80, and the patient felt perfectly comfortable, and the wound was well healed. I propose keeping him in bed for forty-two days.

I think I ought to have some sort of breast-plate of aluminium or felt made to act as a shield to his weakened chest-wall.

I am under no illusions about the future of this patient. I am not so sanguine as to think that because I had the luck to remove this bit of metal all his disabilities will disappear. I think, indeed, that his chest pain is likely to be relieved, and that his pericardial adhesions will not increase, but I certainly expect some permanent "hobbling" of the heart to persist from their re-forming and getting firm. I wish I could have tried, with faith, some means of preventing the re-growth of these adhesions in this rather sacred region.

Lastly, although I do not think it likely, I can imagine that one or other of the great vessels against which the foreign body lay pressed may have had the integrity of its wall damaged, and some sort of aneurysmal change might yet develop.

Reviews.

PRINCIPLES OF DIAGNOSIS AND TREATMENT IN HEART AFFECTIONS. By Sir James Mackenzie. London: Henry Frowde, Hodder and Stoughton. Pp. vii and 264, $8\frac{1}{2} \times 5\frac{3}{4}$. 1916. Price 7s. 6d. net.

This volume embodies material prepared for lectures to be delivered to the workers in the Cardiac Department of the London Hospital before the War, and their chief purpose was to show that the mechanical aids (by which so much of the recent progress in knowledge of everything relating to heart condition has been attributable) are not, in fact, essential for the recognition of the various conditions, though necessary for their investigation, and that ordinary bedside methods will enable these various states to be detected. A further purpose was to endeavour to improve the conception of what is meant by clinical medicine and clinical investigation and to stimulate research.

To those who have any knowledge of Sir James Mackenzie's larger and more important book, in its several editions, it is unnecessary to say that both these objects are fulfilled in the same easy and charming manner which characterizes all his work. As for those who are unacquainted with his previous work, apparently a large number, one can only recommend them to read and absorb the contents of this volume in the hope that its perusal may lead them to further inquiry into these recent developments in modes of observation of and inquiry into cardiac complaints.

It is impossible to deny that part of Sir James Mackenzie's larger book is difficult and needs close application if it is to be properly comprehended. But apart from the more technical discussions, all his writings are pervaded by so much sound common sense and accurate and acute observation that they well repay perusal even by those not specially interested in disorders of the heart, and this volume is free from the difficulties contained in the former.

R. M.

AT SUVLA BAY. By John Hargrave (White Fox). London: Constable and Co., Ltd. 1916. Pp. x and 182. Price 5s. net.

Mr. Hargrave was on the staff of the *Scout* before he enlisted in the R.A.M.C. early in September, 1914. He gives an interesting and amusing account of his training prior to departure for Egypt, and later Suvla Bay.

The story of his—and other people's—adventures is told in a picturesque and often dramatic way, and is illustrated by drawings of different degrees of finish, of which the rough sketches are the best.

This book can hardly be regarded as a serious record of events, but it is worth reading.

EPIDEMICS RESULTING FROM WARS. Professor Dr. Friedrich Prinzing. Edited by Harald Westergaard. Oxford: Clarendon Press. 1916. Pp. xii and 340.

This book is published under the auspices of the Carnegie Endowment for International Peace, part of a series of elaborate investigations which has been undertaken by that body with the laudable but somewhat ingenuous intention of avoiding war by inducing people to judge whether it is reasonable or not; and the fact that the author of a book published with this intention happens to be a German is a cynical accident, if one can impute a personality to an accident.

Something has already been written on epidemics in War; the author gives a bibliography in his first chapter, which is certainly incomplete even as regards German authorities. Dr. Prinzling's book, however, deals not with epidemics in the field, but with outbreaks of disease among the civil population, and, as stated in the introduction by John Bates Clark, the Director of the Carnegie Endowment, "until comparatively recent times the most serious human cost of war has been not losses in the field, nor even the losses from disease in the armies, but the losses from epidemics disseminated among the civil population," referring especially to the smallpox epidemic following the War of 1870, and to the epidemic of typhus fever in Serbia during the present War.

The purpose with which the book is now published in English has obviously nothing to do with its value, which as a summary of historical evidence is considerable. The preparation has involved an immense amount of labour and has been carried out in what one was accustomed to call a thoroughly German way, before the use of this adjective became libellous. It is probable that few reviewers, of whom the present writer is not one, are really competent to analyse and criticize the evidence produced. But after all, the evidence is only confirmatory of what we all now accept—that given privation, hardship, a scarcity of medical assistance both in men and supplies, and the absence of sanitary control, epidemics must and will arise, whose spread it is impossible to estimate beforehand. On our side of the Western Front we appear to have sufficient control, nor do the records of infectious disease in Great Britain show any material increase in disease likely to be contracted from armies in the field. On what is happening elsewhere, and especially behind the German lines, we can only speculate, bearing in mind the bad sanitary history in certain respects of the areas involved.

Two points may be noted. The author gives a perfectly fair account and comment on the conditions in the Concentration Camps during the South African War, and calls attention to the failure of the food supply during the Siege of Paris, giving details and adding that "there was very soon a great scarcity of milk, making it very difficult to feed infants," of some interest in connexion with the present contention of the Germans with regard to the blockade and other means of cutting down their food supply.

Altogether a most instructive book for epidemiologists who want examples for their teaching, and one not without interest for the general public for whom it now seems to be intended.

The Practitioner's Medical Dictionary. By George M. Gould, A.M., M.D. Third Edition, revised and enlarged by R. J. E. Scott, M.A., B.C.L., M.D. London: H. K. Lewis and Co., Ltd. Pp. viii and 962. Price 17s. net.

Careful examination of the third revision of this volume indicates that the editor has left unopened no book which might contain a new word of medical or allied scientific character. Some 20,000 new references have been introduced and we have been surprised at the amount of information now provided in the book; in point of fact it has become a miniature encyclopædia. The scope and usefulness of the work may be judged if it is stated that not only are words defined but the composition also of media, stains, synthetic drugs and proprietary remedies are stated, tests and diagnostic signs are described and abbreviations elucidated. The explanation of terms, to which the names of investigators have been prefixed, forms a prominent and valuable feature.

The work is well printed and bound in limp, brown leather, making it an ornamental as well as a useful adjunct to the medical officer's table.

W. J. D.

The Sex Complex. A Study of the Relationships of the Internal Secretions and the Female Characteristics and Functions in Health and Disease. By W. Blair Bell, B.S., M.D. London: Baillière Tindall and Cox. 1916. Pp. xx and 233. Price 12s. 6d. net.

In this volume Dr. Blair Bell has collected together and expanded the material of several of his earlier communications on the co-relation of the genital functions and the internal secretions. While admitting that full data for generalization are not at present available, he makes in the present work a praiseworthy and conscientious attempt to link up the connexions between the endocritic organs and the sex functions in acordance with our present knowledge. It is worthy of note that many of the facts upon which the author bases his conclusions are derived from his own experimental observations and from clinical cases which he has investigated personally.

The female organism is that principally considered, but it is pointed out that the internal secretions are also closely concerned with the functions of the reproductive system in the male. Evidence is brought forward to show that, besides its primary function of reproduction, the ovary by its hormones modifies the metabolism of the body towards this purpose. Of other endocritic organs, the thyroid, pituitary and suprarenals appear to influence the development of the genitals, the thymus and pineal to prevent sexual precocity, while acting in harmony all the endocritic organs control metabolism in response to the requirements of the genital functions. The psychological aspect of the subject is considered in a special chapter.

In Part II an interesting description is given of the pathology of authenticated cases of hermaphroditism and of the results of pathological changes in the endocritic organs upon the genital functions. The concluding chapter on sexual psychoses might, we think, have been extended with advantage.

The work is exceedingly well written, and the interest of the reader

is stimulated in each chapter. Many new ideas are suggested regarding the treatment of female complaints and the clinical and pathological evidence in regard to the internal secretions has been carefully weighed so that the conclusions drawn are always logical, if not necessarily proven. The author has in this work made a valuable contribution to the literature of a neglected subject; time alone will show whether the many original ideas which he has promulgated will be permanently accepted by the scientific world.

The book is illustrated with many excellent photo-micrographs which confirm the statements made in the text. W. J. D.

SANITATION IN WAR. By Major P. S. Lelean, C.B., F.R.C.S., D.P.H., R.A.M.C., Assistant Professor of Hygiene, Royal Army Medical College. London: J. and A. Churchill. Second Edition, 1917. Pp. viii and 336. Price 6s. net.

The success of the first edition, and the necessity of incorporating the further experience of sanitary officers in the Field have prompted the issue of a second edition.

The work originally issued in the form of lectures has now assumed more definite form, and the heading Chapter has been substituted for that of Lecture.

There is much additional matter which should be of practical use to all medical officers in the field.

In Chapter V we find a new section on mosquitoes, which, in itself, is indicative of the world-wide area occupied by our fighting forces.

The section on protective measures against fly-borne infection has been elaborated, particularly as regards the treatment of horse manure; the prevention of fly-breeding in human excreta, and the methods of destroying flies.

The section on lice has been rewritten.

The investigations of Bacot and others on the bionomics of lice are reviewed with respect to the details of disinfection of person and clothing, and it is comforting to learn that few lice wander on to blankets, and still fewer to straw bedding; but, on the other hand, if the seams of clothing are kept well smeared with grease the pest tends to die out. At the beginning of the War, when the habits and life-history of the louse were imperfectly understood, the problem of delousing seemed to be one fraught with insuperable difficulties. Now, a brigade, with the facilities which have been devised for washing and sterilization, can be "deloused" in two days.

The duties of regimental medical officers have been classified in a way which should do much to dispel the fog of uncertainty as to their responsibilities, apart from sick parade and first-aid in the field.

A new and valuable chapter (No. VIII) on some new departures in field sanitation has been introduced.

The chapter is devoted to diagrams and notes of various conservancy devices, such as fly-proof latrines for use in trenches and behind the lines, incinerators, grease traps, steam sterilizers, improvised camp kitchens with baking ovens, and cold stores.

If time would permit in the short time of training in this country to allow of practical exercises in field conservancy and cooking, all troops should be instructed on the lines set out in these pages. At present, such instruction is practically confined to that given at "Demonstration Centres," and does not sufficiently filter through to all ranks.

We should like to see a small official manual of field hygiene, illustrated with diagrams to scale and giving constructional details, issued for the use of combatant troops.

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Original Communications.

AN ANALYSIS OF RECENT CASES OF TETANUS IN THE BRITISH EXPEDITIONARY FORCE, WITH SPECIAL REFERENCE TO THEIR TREATMENT BY ANTITOXIN.

BY COLONEL SIR WILLIAM B. LEISHMAN, C.B., F.R.S., F.R.C.P., LL.D., K.H.P.

AND

MAJOR A. B. SMALLMAN, D.S.O., M.D., D.P.H.
Royal Army Medical Corps.

SOME of the medical problems of the War, though of much scientific interest, are less urgent than others, and may well await the leisured study which will without doubt be given to them after its conclusion, but others which are more urgent appear to call for at least a partial attempt to reach agreement before the campaign grows older. Prominent among these appears to us the subject of the specific treatment of tetanus, upon which there exist wide differences of view, both as to the usefulness of antitoxin at all, and, admitting its value, as to the system of its employment which may be expected to yield the best results.

Earlier in the War information with regard to tetanus in the Army in France was collected by one of us (W. B. L.), and summarized in one of the sections of the official "Memorandum on Treatment of Injuries in War," which was published in July, 1915, and circulated to all medical officers. Further experience of the treatment of the disease has accumulated since then, but much of

it relates to comparatively small groups of cases observed in a single hospital, and cases fortunately have on the whole been so few that a number of general hospitals may not have seen one for months. Recently a tetanus committee appointed by the War Office, under the chairmanship of Surgeon General Sir David Bruce, has collected a large amount of most useful information in connexion with the cases which have been treated in home hospitals, and have published their results and recommendations, partly in the form of circular memoranda and partly in an article in the *Lancet* of December 2, 1916, by Sir David Bruce. We have remodelled some of our tables upon those adopted by Sir David Bruce so that they may be read as complementary, one to the other, and may in this way serve to bring into greater relief the points in which the experiences of home hospitals are in contrast, or in accord, with those acquired in the Expeditionary Force.

Early last summer it was felt that we had reason to anticipate the occurrence of a certain amount of tetanus among the large number of wounded to be expected during the coming offensive on the Somme. Although since the days of the Battle of the Aisne strict orders exist that every wounded man should receive a prophylactic injection of tetanus antitoxin, and it is exceedingly rare that this is for any reason omitted, still it is well recognized that this cannot confer absolute protection. The severe character of many of the wounds is only too familiar to us all, and the heavy coating of foul mud, with which skin and uniform are almost always plastered, renders it certain that very large doses of anaerobic and other bacteria are at times driven deeply into the devitalized tissues.

Arrangements were therefore organized for the collection of detailed information in respect of every case of tetanus occurring in France, a number of questions being asked on a form which had to be completed and sent to headquarters on the termination or final disposal of the case. The information given on the sheets was then transferred to cards which facilitated the analysis of the various points under inquiry. On the whole, the required details have been very accurately recorded, but it will be realized that at times of heavy pressure in field ambulances and casualty clearing stations it is often difficult or impossible to obtain and record the full details on certain points. These must later be ascertained, if at all, from a man who may be too ill to cross-examine or who may own the notoriously inaccurate memory of at least the old soldier for such points as dates and hours.

We have classed the cases simply into those who died and those who recovered. At first we divided them into three classes: (1) those whose death was attributed solely to tetanus; (2) those whose death was in larger part attributable to complications such as severe sepsis, gas-gangrene, secondary hæmorrhage, etc.; and (3) the recoveries. It was found, however, that the difficulties of deciding in which subdivision to place the fatal cases were too great and the method too uncertain. A simple distribution into the two classes has the disadvantage that the total deaths from tetanus inevitably include a number of cases in which the condition of the wound, the exhaustion of the patient, or some complication, were in themselves quite sufficient to account for death. They also comprise cases in which it was definitely stated that all symptoms of tetanus had disappeared before death. Such cases, naturally, weigh the scales against whatever system of treatment had been employed for the tetanic symptoms. On the other hand, however, the symptoms recorded in some cases have been so slight as to suggest the possibility that they might not have been due to tetanus at all; and, if this were so, such cases would form a counter-weight to those whose death was not due to tetanus.

The present analysis is based upon 160 cases which occurred in hospitals in France, between July 1 and October 31, 1916. Of these cases 118 died and 42 recovered, a case-mortality of 73·7 per cent. This mortality may be contrasted with that of the group of cases, already alluded to, examined by one of us in the spring of 1915. In that series, among 179 cases there were 140 deaths, a case-mortality of 78·2 per cent. This, as far as it goes, does not disclose any considerable degree of improvement in the treatment employed. Both series show a heavier death-rate than that which has been recorded for the cases treated in home hospitals, where during the first year, out of 231 cases analysed by Sir David Bruce there was a case-mortality of 57·7 per cent, and, for the second year, up to July 31, 1916, out of 195 cases a mortality of 49·2 per cent.

These four series show a slight improvement in case-mortality on each side of the Channel, but also make it clear that cases are more fatal in France, by about twenty-five per cent. The causes for the latter fact are so obvious as to need no labouring. The most desperate wounds, which it would be dangerous to move, and which are therefore detained in clearing stations or base hospitals, are just those which are most likely to develop tetanus, and, further, the complications of severe sepsis, gas-gangrene, etc., which must be more in evidence closer to the line than in home

hospitals, more frequently play a large part in determining a fatal issue in cases of tetanus.

INCIDENCE.

It is not permissible at the present moment to give any information upon the actual incidence of the disease among the wounded, or to contrast one period of the War with another from that point of view, but there can be no harm in mentioning an impression, which we have gathered from the figures in question, that the highest incidence will eventually be found to be associated with periods during which heavy fighting took place in wet weather. This, after all, might have been anticipated, as it is obvious that, under such conditions, the change from dust to mud will mean a heavier bacterial inoculation of the wound.

An analysis of the influence of the prophylactic dose of antitoxin upon the general incidence of the disease must, for the same reason, be passed over; but this is, fortunately, a procedure which is so fully accepted, not only by ourselves but by our Allies and our enemies, that it stands in little need of further statistical support. Were it not for the universal acceptance of the protective value of this dose, we feel sure that any analysis of the subject would have had to deal not with a few hundred cases but with many thousands.

THE INFLUENCE OF THE SEVERITY AND CONDITION OF THE WOUND.

In connexion with each case information was asked for on a number of specific points, and among these were queries as to the existence of severe sepsis or gas-infection of the tissues. Details were also asked as to the nature and severity of the wound itself, and whether it was single or multiple. Table I shows the frequency with which these factors were encountered in each group, i.e., among 113 fatal cases and 42 recovered cases. (It will be understood that, where the total number of cases shown in any table does not reach 160, the required information had not been obtained in every case.)

The table shows, as might be expected, a considerably higher percentage occurrence of these conditions among the fatal cases. The most striking contrast is that shown in the much greater frequency of gas-gangrene as a complicating factor in the cases which terminated fatally, no less than 54 per cent of these cases having been noted as suffering from this grave complication. Its

dangerous nature is but too well known, and its frequency among these cases is, to our minds, one of the chief causes of the relatively higher death-rate from tetanus in France, as compared with the experience at home.

TABLE I.

CONDITION OF WOUNDS AS REGARDS SEPSIS, PRESENCE OF GAS GANGRENE, ETC.

	Severe sepsis	Gas gangrene	Extensive or severe wound	Multiple wounds
Fatal, 113 cases	88 (78 per cent)	61 (54 per cent)	98 (87 per cent)	62 (55 per cent)
Recovered, 42 cases	24 (57 per cent)	5 (12 per cent)	26 (61 per cent)	18 (43 per cent)

TABLE II.

THE POSITION OF THE WOUNDS, IN REFERENCE TO THE MORTALITY.

	Body	Limbs
Fatal, 115 cases	61 (53 per cent)	54 (47 per cent)
Recovered, 42 cases	18 (43 per cent)	24 (57 per cent)

Note.—When wounds occurred both on the body and the limbs the case is counted only under the heading "Body."

Another point in connexion with the factors complicating a judgment on the results of treatment appears to be the site of the wound, independently of the influence of sepsis or gangrene. It has been noted by us that a fatal issue is more common when the body, as distinguished from the limbs, has been wounded. Thus, as will be seen in Table II, out of 115 fatal cases, sixty-one, or 53 per cent, were cases in which the wound, or some of the wounds, involved the head or trunk; the balance of fifty-four cases, or 47 per cent, being wounds of a limb or limbs. On the other hand, of forty-two cases which recovered, eighteen, or 43 per cent, were wounds of the body, the remaining twenty-four recoveries—57 per cent of the whole—having received wounds of the legs or arms only. The difference in these figures, though not very marked, appears suggestive, and the heavier mortality of the body cases may not improbably be related to the shorter distance which

the toxin has to travel in order to reach the spinal cord and the nervous centres.

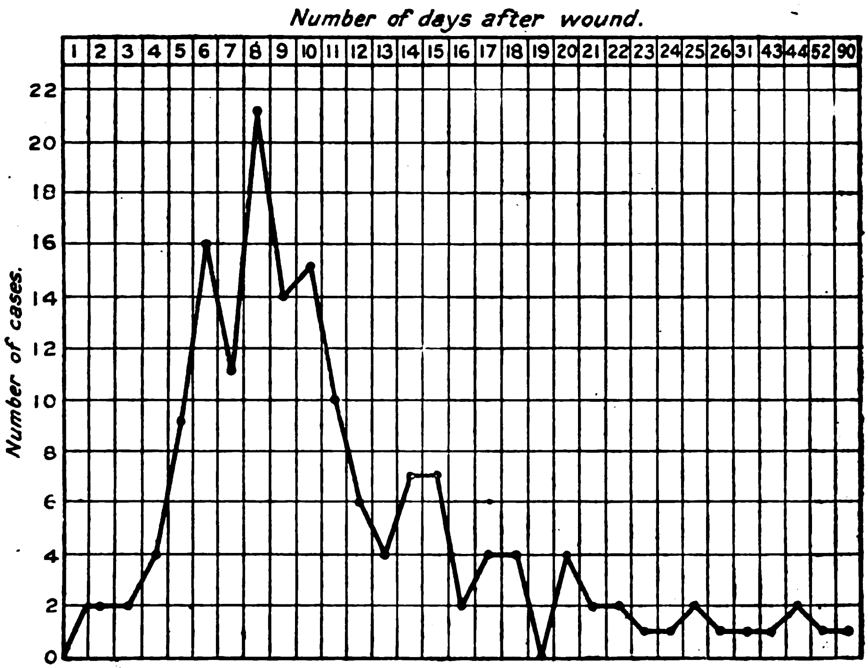
The Incubation Period.

The interval which elapsed between the wound and the first evidences of tetanus was recorded in 157 cases, and a curve has been constructed, similar to that in Sir David Bruce's papers, that the experience in France may be contrasted with that at home. The average incubation period of all the cases was 12·03 days. Of the fatal cases, 115 in number, the average period was 10·7 days, and of the forty-two recoveries it was 14 days. This confirms once again the general experience that the shorter the interval between the wound and the attack, the poorer the chance of the patient. At the same time this difference is less marked than might have been expected, being only a fraction above three days, and it corresponds closely to the figures reported by one of us earlier in the War, where the difference was even smaller—2·74 days. Comparing our curve of the incubation periods with that of the home cases, they appear very similar, except that the peak of the curve in France is reached at an earlier day than in England, the 8th, as contrasted with the 11th. This is only what might have been anticipated, as a larger proportion of the early and the acute cases fall to us. The shortest incubation period mentioned—two days—occurred in two instances, but in one of these there was an element of doubt as to the exact day of wounding. The other was a slight case which recovered, the presumed source of infection having been a small cut on the index-finger. On the other hand, cases of latent or delayed tetanus are naturally more common in home hospitals—the two in our list with the longest recorded intervals after wounding being, respectively, fifty-two days and ninety days. Each of these was fatal; the latter was presumed to have originated from an abrasion of the elbow, and, in the case of the former, an operation had been performed eleven days before the onset of the symptoms of tetanus.

As regards this interesting subject of delayed tetanus, in which it is to be presumed that spores remain undestroyed in the tissues till they are in some way stimulated to germination, we have thirteen cases in our series in which the disease did not make its appearance until twenty-one days or more had elapsed. This may, perhaps, be assumed to be the limit of the normal incubation period, although the phrase is an awkward one to employ in the case of a bacterial disease in which the germs are introduced as spores which,

theoretically, may lie dormant but living in the tissues for an indefinite time. Of these thirteen cases eight died and five recovered. The figures are small, but the recovery rate in this group compares favourably with that of the whole series. The average incubation period of the eight fatal cases was 36·3 days, and that of the five recovered cases 29·4 days.

CURVE OF THE INCUBATION PERIOD.



Influence of Operation before the Onset of Tetanus.

Table III shows a list of the thirty-four cases in which operative interference of a grave nature had been resorted to prior to the development of the first symptoms of tetanus. Of these thirty-four cases twenty-six, or 76·5 per cent died, while eight recovered, a recovery rate of 23.5 per cent. In four cases the onset of the tetanus occurred on the day following the operation, and in another four cases on the second day after operation. In three instances the initial prophylactic subcutaneous dose had been repeated, in two of them 500 units being given a week after the first one. The third case received a second 500 units four days after the first, and 1,500 units eleven days

TABLE III.

OCCURRENCE OF TETANUS AFTER OPERATIVE INTERFERENCE WITH THE WOUND.

Number of cases	Onset of Tetanus		Nature of wound	Nature of operation	Recovered	Died	Duration of disease in days
	Days after wound	Days after operation					
J.13	8	1	Leg	Supracondylar amputation..	—	Died	1
J.15	11	7	Back, face, hands, thigh, legs (bomb) ..	Incisions; removal of necrotic tissue ..	—	,,	19
J.21	8	5	Left thigh, large flesh wound; fractured femur	Amputation middle thigh	—	,,	1
J.22	18	11	Penetrating chest, left; empyema ..	Resection	—	,,	7
J.23	6	3	Shrapnel wound; right arm and fingers; left arm, both legs and buttocks	Exploration and drainage	—	,,	4
J.25	21	9	Scalp, finger, thigh; right arm and elbow	Ligature, brachial, on account of secondary hæmorrhage	—	,,	7
J.26	8	2	Left shoulder; right thigh	Amputation at shoulder-joint	—	,,	2
J.30	12	10	Left forearm; severe flesh wounds ..	Amputation at shoulder	Recovered	—	—
A.11	14	4	Chest, back	Drainage of empyema	—	Died	5
A.23	9	3	Left thigh and leg, fracture; right leg lacerated	Amputation left leg above knee; free excision of muscle	—	,,	2
A.24	10	2	Posterior thoracic hæmothorax, left ..	Aspiration	—	,,	1
A.26	15	12, 1	Dorsum foot, involving bones	(1) Excision and removal of bone; (2) amputation	—	,,	4
A.27	12	8	Gunshot wound chest, penetrating lung..	Extraction of foreign body, chest	—	,,	4
A.35	35	32	Fractured femur into knee-joint	Excision and drainage of joint	Recovered	—	—
A.29	26	16	Penetrating chest; compound fracture forearm	Resection for empyema; cleansing of arm wound	,,	—	—
S.1	6	2	Right shoulder; upper arm	Excision and drainage	—	Died	6
S.7	14	11, 5	Gunshot wound left leg, posterior and outer aspect	(1) Removal of foreign body; drainage; (2) knee joint re-opened	—	,,	6

S.14	8	5	Left leg shot away below knee-joint; right leg and ankle also wounded	Amputation	—	Died	3
S.18	52	11	Compound fracture left humerus	Amputation for severe secondary hæmorrhage	—	,,	4
S.24	8	1	Gunshot wound left hand	Amputation	—	,,	3
S.44	12	6	Lower part of back, non-penetrating; also wound neck	Foreign body removed neck	—	,,	4
S.47	21	16	Right leg, left thigh, right arm, severe back	Amputation right thigh	Recovered	—	—
O.3	15	12, 6	Shell wound right buttock; foreign body lodged in ilium	(1) Excision; (2) removal of foreign body	—	Died	13
O.10	26	23	Left leg, thigh and foot; fracture tibia and metatarsal; foreign body in cornea	Amputation thigh, upper third	—	,,	2
O·11	17	16, 8	Gunshot wound both legs	(1) Amputation upper third left thigh; (2) opening up of stump	—	,,	13
O.19	11	6	Gunshot wound head, left temporo-maxillary joint	Trephined; f. b. removed	Recovered	—	—
O.20	3	0	Gunshot wound right thigh	Opened up	,,	—	—
O.22	7	4, 2, 1	Gunshot wound left chest..	(1) Aspiration; (2) aspiration; (3) rib resection	—	Died	2
O.24	25	10	Both legs; right knee and abdominal wall	Drainage	—	,,	9
O.29	18	14, 10	Compound fracture left upper arm ..	(1) Cleansing, drainage; (2) right arm incisions, left arm disarticulation at shoulder	—	,,	11
O.31	6	4, 2	Compound fracture left ulna, two large dirty wounds; two large dirty wounds left calf	(1) Foreign body removed; (2) cleansing, removal of foreign body	—	,,	4
O.35	43	36	Penetrating right thigh; comminuted fractured femur	Posterior wound enlarged for drainage ..	—	,,	11
O.41	44	9	Compound fracture leg	Amputation below knee	Recovered	—	—
O.43	9	4	Large, over right scalp; small, over right latissimus dorsi	Incision; drainage	,,	—	—

later, on the day of the operation. Of these three cases two died and one recovered, but in the two fatal cases death was not considered as being primarily due to tetanus. The case which had received the three prophylactic doses died, but death was considered to have been due to sepsis and inanition; there had been no convulsions for six days before death. Out of nine cases where death occurred within three days of operation seven were amputation cases; in the two remaining ones the wounds and the operations involved the thorax. On the other hand, out of eight recoveries, three only were amputations, and only in one case was the thorax involved.

It may be noted that 34 out of our 160 cases fall to be described in this category, as contrasted with the 15 cases out of a total of 195 shown on Sir David Bruce's last communication. This disproportion is readily understandable, as these grave operations are naturally demanded more often, and at an earlier moment, in France than in the case of wounded men whose condition was considered such that they could bear the journey to England without undue risk.

Influence of Operation after the Onset of Tetanus.

The practice of operating after tetanus has declared itself appears to be dying out in France. Table IV deals with only nine such cases, and no case of this nature has been reported to us since the end of September. Of the nine cases seven died and two recovered, a case mortality of 77·7 per cent. Of the two cases which were most quickly fatal, viz., one day and one and a half days, it may again be remarked that each was a body wound; the operations apparently involved much manipulation and may thus have opened up fresh channels for the absorption of toxin by a short route. Among the seven deaths there were three amputations, but, on the other hand, both of the recoveries were also amputation cases.

The figures dealt with in these two tables (III and IV) are too small to throw fresh light on a side of the problem which has been much discussed, but we have no doubt as to the wisdom of giving a sufficient prophylactic dose a short time before a contemplated operation, and we believe that it is generally agreed to be wise to refrain from any avoidable disturbance of the wound, or anything in the nature of a severe operation, once tetanus has declared itself, at least until there is some sign of abatement of the symptoms and until a sufficient amount of antitoxin has been administered. The latter question will be mentioned again below.

TABLE IV.

OPERATIVE INTERFERENCE AFTER APPEARANCE OF TETANUS.

Number of case	Onset of tetanus—Days before operation	Nature of wound	Nature of operation	Recovered	Died	Duration of disease in days
J.4	0	Gunshot wound right shoulder; fract. scap.	Incision; cleansing ..	—	Died	1½
J.7	0	Shell wound right thigh; fracture femur	Amputation on appearance of symptoms	—	,,	(?) Not stated
J.10	1	Perforation left leg above ankle	Amputation	Recovered	—	—
J.11	1	Left knee joint	Amputation	—	Died	(?) Not stated
J.16	0	Gunshot wound right upper arm	Incision; drainage ..	—	,,	3
J.29	2	Gunshot wound left foot	Amputation through calf	Recovered	—	—
A.31	3	Thigh	Removal foreign body and drainage	—	Died	8
S.3	0	Near right anterior superior spine; fracture of ilium	Free opening up of wound	—	,,	1
S.5	3	Right tibia; compound fracture wounds, right leg and perineum	Femoral artery tied	—	,,	5

THE PROPHYLACTIC USE OF TETANUS ANTITOXIN.

Although, as has been said, the influence of this upon the general incidence of tetanus in the wounded must be left on one side, there remain some points in connexion with it which are of interest and may be discussed without indiscretion.

It is, of course, well known that the earlier the preventive dose is given after the receipt of the wound the more likely is it to be of use. At the same time there is little positive information as to the effects of delay. An effort was therefore made to obtain precise details as to the number of hours which had elapsed between wound and injection. This was obtained in a considerable proportion of the 160 cases, viz., 66. It would have been easy to group for analysis a still larger number than this if one had been content to include cases in which the replies gave one a reasonable certainty that the dose had been given within twenty-four hours, but only those have been accepted in which a definite statement was forthcoming as to the fact of inoculation, the dosage, and the number of hours after the wound at which the dose was given.

Of the 43 cases which received within twenty-four hours a preventive dose of 500 or more units—less is never given—62·7 per

cent were fatal and 37·2 per cent recovered. On the other hand, of twenty-three cases in which the giving of the antitoxin was, for one reason or another, delayed beyond twenty-four hours, 86·9 per cent died, and only 13 per cent recovered. These figures are given for what they are worth, and it should be borne in mind that delay in giving the preventive inoculation is almost always caused by the impossibility of removing the wounded man from the place where he was hit till military conditions permitted. Such cases are therefore specially liable to gangrene and to the more severe forms of septic trouble.

TABLE V.

Correlation between the Amount of Prophylactic Dose given, the Time of Administration, and the Incubation Period.*

	Interval between wound and prophylactic dose	Number of cases	Percentage	Average prophylactic dose	Average incubation period
Fatal cases, 47 ..	Under 24 hours	27	57·4	655 units	10·6 days
	Over 24 ,,	20	42·6	585 ,,	10·5 ,,
Recovered cases, 19 ..	Under 24 ,,	16	84·3	630 ,,	14·7 ,,
	Over 24 ,,	3	15·7	915 ,,	11·0 ,,

* Incubation period in all cases is reckoned as the interval between the wound and the onset of tetanus, whether there was an intermediate complicating factor, such as operation, or not.

These sixty-six cases are further analysed in Table V to see whether there is any noticeable correlation between the time of administration of the preventive dose, the average size of this dose, and the length of the incubation period. The chief points which emerged from this were that the average incubation period of the recovery cases who got their preventive dose within twenty-four hours is longer than that of the other classes, and that, of those whose dose was delayed, and who yet recovered, the average size of the dose given was large, viz., 915 units.

No prophylactic dose was given in fifteen of the cases, and nine of these died—i.e., sixty per cent. It is to be noted, however, that, of the six who recovered, five were instances of men whose injuries, being of the nature of scratches or abrasions, were so slight that they did not report sick, and hence received no dose of serum. Others of those who received no serum were of that unlucky class who have only been picked up some days after their injury, having lain unfound in some shell-hole, or, perhaps, in such a portion of

"No man's land" as made it impossible to reach them. Their condition on rescue has sometimes been so critical that the medical officer did not consider it wise to give an inoculation.

The Therapeutic Use of Tetanus Antitoxin.

The "questionnaire" completed in all cases of tetanus was principally designed to obtain accurate information upon the details of antitoxin administration, the number, size and route of introduction, and the dates of each dose being asked. This information has been given in every case and has formed the subject of close study, from as many different points of view as possible. Our thanks are due to the officers who furnished us with these details, collected often under conditions of great stress. Our object, it need hardly be said, was to search the collected results for any indications for or against a particular system of dosage, or a particular channel or combination of channels of administration of the antitoxin.

Of the 160 cases, all but three, each of them fatal, were treated with antitoxin, so the tables now to be discussed deal with 157 cases.

The number of possible variations in the treatment adopted, as well as the various complications already alluded to, make it a very difficult matter to arrive at a clear-cut answer to any given question, and had there been more general agreement on the usefulness of antitoxin in the treatment of declared tetanus and on the best methods of employing it, we should have preferred to wait till more material had become available for analysis. Still, certain points have rather forced themselves upon our notice in our inquiry into the returns, and we believe them to be of sufficient importance to put on record forthwith.

The paper of Sir David Bruce, dealing as it does with a further 175 cases treated with antitoxin in Home Hospitals, forms a ready means of multiplying experience on certain points, and we shall frequently avail ourselves of the opportunity thus given of comparing our respective experiences and conclusions.

In examining the results of a certain line of treatment we have, as already said, been content to accept as the criterion of success or failure the survival or death of the patient, leaving out of consideration any statement that death was due in the main to some other cause than tetanus.

Table VI shows the cases distributed in accordance with the

TABLE VI.

SHOWING THE TOTAL NUMBER OF CASES TREATED BY SERUM, GROUPED ACCORDING TO THE TOTAL DOSAGE GIVEN, TOGETHER WITH THE CASE MORTALITY THE GROUPS ARE SUBDIVIDED TO SHOW HOW MANY CASES FALL INTO EACH ONE OF THE FIFTEEN POSSIBLE COMBINATIONS.

Dose (in units)	Number of cases	Died	Case mortality	Methods of Administration*														
				T	V	S	M	TV	TS	TM	VS	VM	SM	TVS	TSM	VSM	TVM	TVSM
Below 500	5	4	80 per cent	3	—	2	—	—	—	—	—	—	—	—	—	—	—	—
501—1,000	3	3	100 ,,	2	—	1	—	—	—	—	—	—	—	—	—	—	—	—
1,001—5,000	49	42	85 ,,	12	5	16	2	2	8	2	—	—	—	1	—	1	—	—
5,001—10,000	25	16	64 ,,	6	—	4	1	3	6	2	—	—	—	1	1	—	1	—
10,001—20,000	34	26	76 ,,	2	1	2	1	5	9	5	1	—	—	6	1	—	1	—
20,001—50,000	25	16	64 ,,	—	—	1	—	1	4	3	2	—	—	10	2	—	2	—
50,001—100,000	14	6	43 ,,	—	1	1	—	3	1	1	1	2	—	2	—	—	1	1
Above 100,000	2	2	100 ,,	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1
Totals ..	157	115	73·7 ,,	25	7	27	4	14	28	13	4	2	1	20	4	1	5	2

* T = Intrathecal. V = Intravenous.
S = Subcutaneous. M = Intramuscular.

total amount of antitoxin which they had received, being arbitrarily divided for this purpose into eight classes. In each group is shown the number of deaths, the case mortality, and the channels of administration by which the serum had been given. As will be seen, there are no fewer than fifteen possible combinations of the four routes which we have had under consideration and there are instances of each of these combinations having been employed. We have taken no account of a few cases in which antitoxin was said to have been given by the mouth or by the rectum, and there has been no report of its local application to the wound.

For the sake of brevity we shall in our tables employ an initial letter to signify the particular route, thus "T" = the intrathecal method, "V" = the intravenous, "S" = the subcutaneous, and "M" = the intramuscular.

We shall leave the tables largely to speak for themselves, when they have anything to say, confining our comments to such points as appear to us of significance or as needing further explanation or emphasis.

As regards Table VI, the chief point sought was any broad indication of the effects of the total dosage of antitoxin. In studying this point, we at one time divided our cases accordingly as they had received a total dosage of less or more than 20,000 units. Although we decided later to abandon this method for the succeeding tables, as too complicating, we may return to it here as bringing out the desired point somewhat more clearly. As will be seen, the first five classes, those in which the total dosage had been below 20,000 units, comprise 116 cases, of whom ninety-one died, a case mortality of 78·4 per cent. The remaining forty-one cases received more than 20,000 units and of them twenty-four died, a case mortality of 58·5 per cent. There is, therefore, a balance of twenty per cent in favour of the larger dosage. Turning to a somewhat similar table in connexion with the cases treated in Home Hospitals, and dividing the 175 cases therein analysed into similar groups, below and above a total dosage of 20,000 units, we find that of 108 cases in the small-dose category, sixty-one died, a case mortality of 56·4 per cent; while of the sixty-seven cases in the large-dose class only twenty-one died, a case mortality of 31·3 per cent. The balance here in favour of the larger total dosage is twenty-five per cent, a difference even more pronounced than in our own series.

Taken together, we think there can be little doubt that they demonstrate the better results obtainable from the higher dosage.

We have very closely scrutinized our cases to see what influence certain obviously possible fallacies might have had upon this conclusion. For instance, it is possible that relatively small dosage may have been adopted of necessity because the case was rapidly fatal, either from tetanus or a complication; or, on the other hand, the case may have been so slight that the dosage was originally small and was rapidly abandoned. Such cases undoubtedly occur, but against them may be set, unfortunately, the equally certain fallacy that even in severe and prolonged cases the dosage recorded has, in our view at least, been altogether inadequate, owing to an obvious unbelief in the value of specific treatment. These, and some other disturbing factors, we think tend to cancel one another and we do not consider that they lessen materially the significance of the figures just quoted.

TABLE VII.

SHOWING THE TOTAL NUMBER OF CASES TREATED BY SERUM (WITH OR WITHOUT NON-SPECIFIC TREATMENT) TOGETHER WITH THE NUMBER OF DEATHS AND THE CASE MORTALITY PER CENTUM. THE TABLE ALSO SHOWS THE NUMBER OF CASES TREATED BY ANY ONE OF THE FOUR AVAILABLE ROUTES ALONE OR IN COMBINATION WITH ONE OR MORE OF THE OTHER THREE ROUTES.

Methods of administration	Number of cases	Number of deaths	Case mortality
T	25	21	84 per cent
V	7	7	100 ,,
S	27	15	55 ,,
M	4	3	75 ,,
TV	14	11	78 ,,
TS	28	21	75 ,,
TM	13	9	69 ,,
VS	4	4	100 ,,
VM	2	0	0 ,,
SM	1	1	100 ,,
TVS	20	17	85 ,,
TSM	4	1	25 ,,
TVM	5	3	60 ,,
VSM	1	1	100 ,,
TVSM	2	1	50 ,,
Totals	157	115	73 per cent

The next table (VII) sets out the cases treated by antitoxin and it shows each route or combination of routes by which the serum was given, the number of cases, the deaths, and the case mortality. The uneven size of the groups and their very number make evident the futility of any attempt to form conclusions from a consideration of the degree to which the case-mortalities are

above or below the mean rate of the whole 157 cases. A better opportunity is afforded by a consideration of the series of tables (VIII, IX, X and XI) in which the cases are grouped on a different system. Here we have placed together all cases in which one particular route, whether alone or in combination with others, formed part of the system of treatment, a separate table being devoted to each of the four, "T," "V," "S" and "M." Each of these will now be briefly considered.

TABLE VIII.

SHOWING ALL CASES TREATED BY THE INTRATHECAL ROUTE, EITHER ALONE OR IN COMBINATION WITH ONE OR MORE OF THE OTHER ROUTES, TOGETHER WITH THE NUMBER OF DEATHS AND THE CASE MORTALITY.

Methods of administration	Number of cases	Number of deaths	Case mortality
T	25	21	84 per cent
TV	14	11	79 ,,
TS	28	21	75 ,,
TM..	13	9	69 ,,
TVS	20	17	85 ,,
TSM	4	1	25 ,,
TVM	5	3	60 ,,
TVSM	2	1	50 ,,
Totals	111	84	75 per cent

Table VIII deals with the intrathecal route, employed either alone or combined with others. It was used alone in twenty-five cases with a mortality of 84 per cent; and this, with the single exception of the combination "TVS," is, it will be noted, the highest rate shown in the table. Looking to Sir David Bruce's figures, we see that "T" was used alone in seven cases, of which five died, a mortality of 71·4 per cent, the highest mortality of any group analysed in his paper. So far, this does not impress one favourably. Turning to the use of "T" in combination with others, the only other point we shall call attention to is that in each of the four groups showing the lowest mortality the intramuscular route has formed a part of the combination. The moral would appear to be that if one employs the thecal route at all it is better to use it in combination than alone. This is even more strikingly illustrated in the Home figures, where the relative death rates are 71·4 per cent and 46·7 per cent.

Table IX deals in a similar way with the intravenous route, alone or combined. Of fifty-five cases in the group forty-four died, a mortality of 80 per cent, and we have the striking fact brought

out that no case treated by this channel alone recovered. In the Home figures the mortality in seven cases treated by "V" alone was 57 per cent, the second highest in the list. Looking again at the results of the various combinations of "V" with other channels, one again notes that the three lowest mortalities are in groups in which "M" appears.

TABLE IX.

SHOWING ALL CASES TREATED BY THE INTRAVENOUS ROUTE, EITHER ALONE OR IN COMBINATION WITH ONE OR MORE OF THE OTHER ROUTES, TOGETHER WITH THE NUMBER OF DEATHS AND THE CASE MORTALITY.

Methods of administration	Number of cases	Number of deaths	Case mortality
V	7	7	100 per cent
VT	14	11	79 ,,
VS	4	4	100 ,,
VM	2	0	0 ,,
VTS	20	17	85 ,,
VTM	5	3	60 ,,
VSM	1	1	100 ,,
VTSM	2	1	50 ,,
Totals	55	44	80 per cent

TABLE X.

SHOWING ALL CASES TREATED BY THE SUBCUTANEOUS ROUTE, EITHER ALONE OR IN COMBINATION WITH ONE OR MORE OF THE OTHER ROUTES, TOGETHER WITH THE NUMBER OF DEATHS AND CASE MORTALITY.

Methods of administration	Number of cases	Number of deaths	Case mortality
S	27	15	55 per cent
ST	28	21	75 ,,
SV	4	4	100 ,,
SM	1	1	100 ,,
STV	20	17	85 ,,
STM	4	1	25 ,,
SVM	1	1	100 ,,
STVM	2	1	50 ,,
Totals	87	61	70 per cent

Table X shows the subcutaneous route alone and in combination with others. Of eighty-seven cases in which this route was employed the general case mortality was 70 per cent. When used alone, in twenty-seven cases, the mortality was considerably lower, 55 per cent, and here the apparent effect of combining this route with others is bad, except in two particular combinations, into each of which "M" again enters.

In the Home figures the mortality from cases treated by "S" alone was 50 per cent, but there is no information as to the frequency with which it was employed in combination.

TABLE XI.

SHOWING ALL CASES TREATED BY THE INTRAMUSCULAR ROUTE, EITHER ALONE OR IN COMBINATION WITH ONE OR MORE OF THE OTHER ROUTES, TOGETHER WITH THE DEATHS AND THE CASE MORTALITY.

Methods of administration	Number of cases	Number of deaths	Case mortality
M	4	3	75 per cent
MT..	13	9	69 ,,
MV..	2	0	0 ,,
MS..	1	1	100 ,,
MTS	4	1	25 ,,
MTV	5	3	60 ,,
MVS	1	1	100 ,,
MTVS	2	1	50 ,,
Totals	32	19	59 per cent

Table XI, the last of this group of four, deals in similar fashion with the intramuscular route. Of thirty-two cases in which it played a part, nineteen died, a case mortality of 59 per cent, the lowest figure by 11 per cent of the four tables. The groups are too small here to afford much information and, so far as the figures go, the mortality resulting from its use alone, 75 per cent, contrasts unfavourably with the mean rate of 59 per cent. This group, however, deals with but four cases and may be usefully supplemented by the Home figures, which show that of eight cases treated by this method alone only one died, a mortality of 12·5 per cent. Combining these eight cases with our own four, we have four deaths out of twelve cases, a mortality of 33·3 per cent, which is by far the lowest recorded in either series for the results of a single-channel antitoxin treatment.

We fully appreciate the many pitfalls into which one may stumble in searching for truth among small figures dealing with cases presenting so many complicating factors, but, so far, our examination of them has given us some strong impressions, all the stronger in that they were by no means anticipated. They appear to us to throw very considerable doubt upon the advisability of employing the intrathecal route, either alone or in combination, and, further, they seem to indicate considerable virtues in connexion with the employment of the subcutaneous and intramuscular channels, particularly the latter. The evidence for and against the

intravenous method also leaves one with a feeling of suspicion, particularly in view of the fact that all of the cases treated by this channel alone died.

Effects of the Dosage of Antitoxin employed by the Several Routes.

It is obvious, however, that, in considering the results of the various combinations of specific treatment dealt with in the last four tables (VIII, IX, X and XI) there is a factor of importance which is not disclosed by them, but which it is essential to consider. It is not enough to treat all cases as alike that have received serum treatment by the same combination of routes; we must study the amount and frequency of the dosage by each route if we are to reach a fairer judgment of results. This has accordingly been done and every individual case has been closely studied from this point of view. A table showing the full details of every dose given in the 157 cases was constructed, but as this would be too elaborate to reproduce, we have constructed Tables XII, XIII, XIV and XV, which, while repeating the classification of cases adopted in Tables VIII, IX, X and XI, show, in addition, the average amount of antitoxin given by each route in each group of cases. This table enables one to grasp more readily the relative importance to attach to each route in any given combination of routes, and to see how this factor of dosage compares in the cases which recovered and those which died.

Table XII displays all cases in which the intrathecal route played a part. Contrasting the average dose given by the thecal route in the fatal and recovered cases, respectively, and in each combination, it will be seen that there is no regularity; in some instances more had been given in the recovered cases, in others less. Looking then at the venous fraction, here too we see no regularity; a larger dosage by the veins seems in some cases to have been beneficial, in others the reverse. But when we consider the remaining fractions, subcutaneous and intramuscular, in each group into which they enter, we notice in all cases that the dosage has been higher, usually much higher, in the recovery cases than in the fatal ones. It should be noted, however, that neither in this nor the succeeding three tables of the series do we attempt to draw any inferences from the two cases in class "TVSM," the employment of all four routes appearing to us to render any attempt of this sort futile.

TABLE XII.

CASES TREATED BY THE INTRATHECAL METHOD, EITHER ALONE OR IN COMBINATION WITH ONE, TWO OR THREE OTHER METHODS. CONTRAST OF THE AVERAGE AMOUNTS OF ANTITOXIN USED IN THE FATAL AND RECOVERY CASES.

Method of administration	Number of fatal cases	Average amount used by each route	Number of recoveries	Average amount used by each route	Case mortality
T	21	3,810	4	7,250	84 per cent
T V	11	4,470 14,345	3	3,000 24,000	79 per cent
T S	21	4,050 6,950	7	8,000 18,000	75 per cent
T M	9	4,970 6,500	4	12,560 27,560	69 per cent
T V S	17	6,430 12,535 7,985	3	3,750 13,500 25,500	85 per cent
T S M	1	7,500 3,000 6,000	3	4,300 6,170 11,800	25 per cent
T V M	3	4,170 15,500 8,330	2	7,500 5,250 12,750	60 per cent
T V S M	1	18,000 100,000 50,500 34,000	1	8,000 14,000 17,500 4,500	50 per cent
Totals ..	84	—	27	—	75 per cent

Table XIII deals in similar fashion with the intravenous route, in all combinations. Analysis in this group is difficult, as in no less than four of the combinations we have either no deaths or no recoveries, as well as the group "VTSM," of which we take no notice. The two groups most suitable for contrast, on account of the number of cases, are VT," where the recovered cases show a larger venous dose and a smaller thecal one than the fatal cases, and group "VTS," in which, while the venous average dose is approximately equal in fatal and recovered cases, we are struck by the fact that in three recoveries only half the thecal dose was given, but three times the subcutaneous dose, as contrasted with the dosage given in the seventeen fatal cases.

TABLE XIII.

CASES TREATED BY THE INTRAVENOUS METHOD, EITHER ALONE OR IN COMBINATION WITH ONE, TWO OR THREE OTHER METHODS. CONTRAST OF THE AVERAGE AMOUNT OF ANTITOXIN USED IN THE FATAL AND RECOVERY CASES.

Method of administration	Number of fatal cases	Average amount used by each route	Number of recoveries	Average amount used by each route	Case mortality
V	7	13,890	0	–	100 per cent
V T	11	14,345 4,470	3	24,000 3,000	78 per cent
V S	4	9,875 18,000	0	0	100 per cent
V M	0	—	2	60,000 24,000	0 per cent
V T S	17	12,535 6,430 7,985	3	13,500 3,750 25,500	85 per cent
V T M	3	15,500 4,170 8,330	2	5,250 7,500 12,750	60 per cent
V S M	1	500 1,000 3,000	0	0	100 per cent
V T S M	1	100,000 18,000 50,500 34,000	1	14,000 8,000 17,500 4,500	50 per cent
Totals ..	44	—	11	—	80 per cent

Table XIV, dealing with the dosage of the subcutaneous route, alone or combined, brings out more clearly than the others the observation that, in all groups in which we are able to make a comparison between the dosage in the recovered and in the fatal cases, a much higher average dose has been given to the cases which lived. This is particularly noticeable in the group treated by the subcutaneous method alone, where the average dose has been 4½ times higher in the cases which recovered, and in the two other fair-sized groups, "ST" and "STV," in which the subcutaneous dose was, respectively, 2½ and 3½ times greater in the recovery cases. In all, this table impresses us with the value of high dosage when the subcutaneous route is employed.

TABLE XIV.

CASES TREATED BY THE SUBCUTANEOUS METHOD EITHER ALONE OR IN COMBINATION WITH ONE, TWO OR THREE OTHER METHODS. CONTRAST OF THE AVERAGE AMOUNTS OF ANTITOXIN USED IN THE FATAL AND RECOVERY CASES.

Method of administration	Number of fatal cases	Average amount used by each route	Number of recoveries	Average amount used by each route	Case mortality
S	15	2,450	12	11,500	55 per cent
S T	21	6,950 4,050	7	18,000 8,000	75 per cent
S V	4	18,000 9,875	0	—	100 per cent
S M	1	60,000 60,000	0	—	100 per cent
S T V	17	7,895 6,430 12,535	3	25,500 3,750 13,500	85 per cent
S T M	1	3,000 7,500 6,000	3	6,170 4,300 11,800	25 per cent
S V M	1	1,000 500 3,000	0	—	100 per cent
S T V M	1	50,500 18,000 100,000 34,000	1	17,500 8,000 14,000 4,500	50 per cent
Totals ..	61	—	26	—	70 per cent

Table XV, the last of this series, shows the average dose of antitoxin employed in all combinations in which the intramuscular route was used. The various groups in this category are, on the whole, too small to extract from them much guidance in this matter of dosage, but it will be seen that in the largest group, "MT," dealing with thirteen cases, about four times as much antitoxin was given intramuscularly in the recovered cases as in those which died. In the "MTS" cases, in which three recovered and one died, the intramuscular dose was twice as great in those who lived. On the other hand, in the cases treated by intramuscular injections alone, of which three out of four were fatal, the only case which recovered received less than half of the average dose given to the fatal cases. On the whole, although the

figures are small, we get the same impression here as in the instance of the subcutaneous route, that the apparently favourable effect of employing this channel is associated with a proportionally high dosage.

TABLE XV.

CASES TREATED BY THE INTRAMUSCULAR METHOD, EITHER ALONE OR IN COMBINATION WITH ONE, TWO, THREE, OR OTHER METHODS. CONTRAST OF THE AVERAGE AMOUNTS OF ANTITOXIN USED IN THE FATAL AND RECOVERY CASES.

Method of administration	Number of fatal cases	Average amount used by each route	Number of recoveries	Average amount used by each route	Case mortality
M	3	7,500	1	3,000	75 per cent
M T	9	6,500 4,970	4	27,560 12,560	69 per cent
M V	0	–	2	24,000 60,000	0 per cent
M S	1	60,000 60,000	0	–	100 per cent
M T V	3	8,330 4,170 15,500	2	12,750 7,500 5,250	60 per cent
M T S	1	6,000 7,500 3,000	3	11,800 4,300 6,170	25 per cent
M V S	1	3,000 500 1,000	0	–	100 per cent
M T V S	1	34,000 18,000 100,000 50,500	1	4,500 8,000 14,000 17,500	50 per cent
Totals ..	19	—	13	—	59 per cent

On regarding these four tables from a general point of view, and without attempting to draw from them more than may reasonably be inferred, we find our suspicions of the thecal and venous routes strengthened, and also some further support for the good impression which had been made on us by a consideration of the results of the subcutaneous and intramuscular routes.

The last table which we shall give, Table XVI, was designed in an attempt to visualize and contrast the results obtained by single-route administration of antitoxin, with the results of using that particular route in combination with others.

TABLE XVI.

COMPARING AND CONTRASTING THE RESULTS OBTAINED BY EACH ROUTE INDIVIDUALLY WITH THOSE OBTAINED BY THAT ROUTE IN COMBINATION WITH ONE OR MORE OTHERS.

	Total cases treated	Average dosage employed, thecal route	Died: Number of cases	Died: Case mortality	Died: Average dosage, thecal route	Recovered: Number of cases	Recovered: Recovery rate	Recovered: Average dosage, thecal route
Intrathecal route only ..	25	4,360	21	84 per cent	9,810	4	16 per cent	7,250
Intrathecal combined with other routes	86	5,680	63	73·2 ,,	5,180	23	26·7 ,,	7,060

	Total cases treated	Average dosage employed, venous route	Died: Number of cases	Died: Case mortality	Died: Average dosage, venous route	Recovered: Number of cases	Recovered: Recovery rate	Recovered: Average dosage, venous route
Intravenous route only ..	7	13,890	7	100 per cent	13,890	0	0	—
Intravenous combined with other routes	48	16,966	37	77 ,,	15,062	11	23 per cent	23,360

	Total cases treated	Average dosage employed, subcutaneous route	Died: Number of cases	Died: Case mortality	Died: Average dosage, subcutaneous route	Recovered: Number of cases	Recovered: Recovery rate	Recovered: Average dosage, subcutaneous route
Subcutaneous route only ..	27	6,470	15	56 per cent	2,450	12	44 per cent	4,500
Subcutaneous combined with other routes	60	11,780	46	77 ,,	10,178	14	23 ,,	17,036

	Total cases treated	Average dosage employed, muscular route	Died: Number of cases	Died: Case mortality	Died: Average dosage, muscular route	Recovered: Number of cases	Recovered: Recovery rate	Recovered: Average dosage, muscular route
Intramuscular route only ..	4	6,375	3	75 per cent	7,500	1	25 per cent	3,000
Intramuscular combined with other routes	28	14,650	16	57 ,,	11,655	12	43 ,,	18,640

Looking at the intrathecal results, we see that the case mortality is ten per cent higher when this route is used alone, and also that the total dosage given by the thecal route in the fatal cases was considerably higher in the group in which this channel was employed along with others than when it was employed alone. It was remarked, however, that a considerable proportion of the twenty-one fatal cases treated by the single-route method were exceptionally severe cases of gunshot injuries. In nine of them death was attributed by the reporting officer to causes other than tetanus. Thirteen of them died within twenty-four hours of the first appearance of tetanic symptoms. Of the four recovery cases all were noted as being either slight or localized, and none of them reached the stage of trismus.

As regards the intravenous channel, attention has already been directed to the fatal issue in all cases treated by this method alone. The high dosage employed will be remarked, as well as the fact that the average dose given to the recovered cases in whom this channel had been used in combination with others was highest of all. In examining the individual records of the seven fatal cases treated by the venoüs route only it was remarked that, although they were all severe wounds, the antitoxin was not persisted in in several, though time allowed for its repetition. In only two out of the seven was the dose above 5,000 units.

The subcutaneous route employed alone shows the lowest mortality, viz., fifty-six per cent. Of the fifteen fatal cases seven were severe wounds, in which death was not attributed directly to the tetanus. The dosage employed in these fatal cases was also remarked upon as being very small, in only one of them was it over 3,000 units and most received 1,500 units or less. Of the twelve recoveries in the single-route group six were either localized or slight, but the dosage only fell below 3,000 units in one case, which received 500. The wounds in this group were, on the whole, slight.

Too few cases were treated by the intramuscular route alone to allow of effective contrast with those in which this method was associated with others. Of the three fatal cases two were specially severe wounds and the intramuscular dosage was moderate. The recovery case, although severe, was, on the other hand, given 3,000 units only. The high average dosage given into the muscles in the twelve recovery cases in the combined group, 18,640 units, is also noteworthy.

GENERAL COMMENTARY.

The above analysis of these tables dealing with the therapeutic employment of tetanus antitoxin leaves, we are fully aware, much to be desired and, at any other time than this, we should have greatly preferred to postpone this article until our material was larger. The importance and urgency of the subject, however, form our justification, and we shall now proceed to summarize the impressions we ourselves have gathered, trusting that we have presented the available facts in such a way that any who wish may do the same.

Our general conclusions would place the alternative channels of administration of the antitoxin in the following order of merit: intramuscular, subcutaneous, intrathecal, and intravenous. Let us consider each separately, emphasizing the points of experience or theory which have influenced our judgment. Taking the intravenous route first, as we have placed it last, we are in full agreement with the recommendation of the Tetanus Committee in their revised memorandum, that this route should not be used; not only does it introduce a risk of anaphylactic shock, from which other methods are practically free, but it appears to us from our records that it has done little, if any, good in treatment. It seems improbable that, even when very large doses are injected into the veins, the antitoxin is likely to be brought to the point at which it is most wanted in a sufficiently concentrated form. Of what is injected only a small fraction can possibly be utilized and, further, we do not think that the effects of the antiseptic which is mixed with most brands of antitoxin can altogether be neglected when large and repeated doses are injected by this channel.

As to the intrathecal route, we are less inclined to support the recommendation contained in the memorandum just mentioned, when it says "In a case of tetanus the first thing to do is to give an intrathecal injection of antitoxin." The study of our own cases has not impressed us at all favourably. Sir David Bruce, in his article of December 2, considers that the evidence for and against it from his series of cases at Home hospitals is not conclusive. We are inclined to go further and consider, from our own tables, and also to some extent from his, that the evidence is pretty strongly against its employment. The theoretical grounds for the adoption of the thecal route are, of course, well known and depend chiefly on the hope that by bringing antitoxin into more or less close contact with the poisoned nerve cells of the cord, we may effect a dissociation between the cell and the molecules of toxin which it

has bound to itself. It is known to be very difficult to introduce antitoxin into the cerebrospinal fluid by means of the blood-stream, hence the direct path chosen in lumbar puncture. We shall not attempt to analyse the experimental evidence bearing upon this subject, but think it will be agreed that a considerable divergence of opinion still exists as to whether what we aim at, a dissociation of toxin from the poisoned nerve cell, is realizable in practice. The good effect of intrathecal injections of serum in some cases of cerebrospinal meningitis has really no bearing upon this problem, because, in that instance, we are directly attacking an organism which we know to be present in the fluid into which we introduce our anti-serum. Again, in that disease marked benefit often results from the mere evacuation of the turbid fluid which has accumulated under pressure, without even replacing it by an injection of serum. Apart, however, from doubts as to the soundness of its theoretical basis the method appears to us to possess some very definite disadvantages and dangers. For example, the dangers of contamination of the needle track, in spite of scrupulous precautions at the time of operation, must be very considerable in certain cases. At all events definite comments have been made in connexion with some of our cases that thecal injections have been followed by signs of meningeal irritation, and one of us has seen specimens of cords, removed after death from tetanus, in which there was definite evidence of meningitis having followed the lumbar punctures. Again, although Flexner and others have stated that the amount of antiseptic usually added to antitoxin as a preservative is no impediment to its employment by the thecal route, we do not think that repeated injections of carbolic acid, tricresol, etc., can be altogether a negligible consideration in the case of a canal whose limiting membranes are so delicately constituted and their functions so imperfectly understood, to say nothing of possibly adding to the grave irritation already present in the adjoining nerve cells of the motor tracts owing to the action of tetanus toxin. In at least one case death followed rapidly upon a thecal dose when the patient was said to have been progressing favourably. It was attributed to anaphylactic shock.

Although we have this decided impression that the intrathecal route may be a dangerous one and do not feel its theoretical foundations to be as secure as one would like, still we have a fair number of instances in which the reporting medical officer was struck with the apparent benefit following a thecal dose, and of course, as our tables show, it has formed a part of the treatment in twenty-seven cases which recovered.

If it is desired to employ this method we think that its use should be very carefully watched, that exceptional care should be taken to guard against possible contamination of the canal through the needle puncture, that the serum should contain no preservative, and that it is undesirable to withdraw more than ten to fifteen cubic centimetres of cerebrospinal fluid or to replace this by a greater volume of antitoxin. It might be advisable to employ for this purpose a solution of desiccated antitoxin, which would be free from preservatives and could be rapidly prepared under sterile conditions in the desired concentration.

The subcutaneous and intramuscular routes may appropriately be considered together, as they are essentially similar in action, each being a comparatively slow and continuous method of dosage as distinguished from the rapid introduction involved in the venous and thecal methods. While we have expressed our unfavourable impressions in respect of these rapid methods, we have in the present case received a strongly favourable impression, which is confirmed to some extent by the results obtained in the Home hospitals. Hitherto these two routes have been looked on as merely supplementary to the others and as being of chief value when it was desired to maintain a moderate concentration of antitoxin in the system after the critical period was past, and with a view to warding off a possible relapse. We think, on grounds both of theory and observation, that they might be promoted to a more dignified position. We believe our records show that when these two paths of introduction have been utilized freely, and where the dosage has been sufficient, the results as regards saving of life have been more satisfactory than when they were not utilized, or were used in altogether too restricted a fashion.

Turning to the theoretical aspect, we may follow for a moment the path by which the toxin is believed to travel on its way to the central nervous system. It is generally accepted that it travels by way of the motor nerves, though it is still a matter of debate whether it progresses through the axis cylinders or through the lymphatics which accompany these nerves. At all events, the general blood-stream and lymph-stream are considered to play but a small part. Once the tetanus spores have found conditions suitable for their germination, and the bacteria themselves are multiplying without interference in some nook or cranny of the wound, the formation of the toxin goes on continuously. It is possible that this toxin at times may accumulate locally and only upon some local disturbance of the wound does it become absorbed

in quantity, producing probably a rapid and fulminating attack. At other times the toxin may be slowly but continuously taken up by the nerves, as it is formed, and this may lead to a comparatively slow onset of the disease. In either case we have then to deal with a localized factory of the toxin, which is either continuously or discontinuously absorbed along the nerves. Looking now at the possibilities of neutralizing this toxin: we have in our hands a perfect antidote, of that there can be no question, and the problem becomes clear that it is an affair of trying to bring antidote and poison in contact with one another, within the shortest time and under the most favourable conditions for neutralization to take place. The alternative lines of attack are three, and no more: the local factory of toxin, the line of transit of the toxin to the central nervous system, and the central nervous system itself. The first would of course be the ideal one to select, but, unfortunately, we cannot locate it with precision, and attempts to reach it and deal with it by surgical measures, or by the local application of various antiseptics or oxidizing agents, more often than not end in failure or in a sudden outpouring and absorption of toxin. The last, the central nervous system, is difficult to reach and, at the best, this is an attempt to re-capture from the enemy a position which they have already taken and hold in great strength. The method of intrathecal injection aims at such a local assault but depends for its possible success on two assumptions, namely, that the antitoxin shall actually come into contact with the nerve cells which are poisoned and, having come into contact with them, shall be able to neutralize or withdraw from these cells the tetanus toxin which had reached them. In practice, the results of this line of attack appear to us, from our own and the Home cases, to be most disappointing.

The chances of success by employing the third alternative, an attack on the lines of communication, would appear more hopeful, especially if this could be done by some method which would keep up the antitoxin attack steadily and continuously on the path over which it is probable the toxin must travel. To effect this there appear to be grounds for considering that the subcutaneous and the intramuscular channels offer greater prospects of success than the intravenous method, for the reason that the dose of antitoxin thrown into the veins is immediately diluted by the whole volume of the blood and subsequently of the lymph, and by the time any portion of it comes round to the site where it is required it must be very dilute indeed. On the other hand, antitoxin injected beneath the

skin or into the muscles is said to be absorbed but slowly, taking, it is stated, forty-eight hours in the case of the subcutaneous site and twenty-four in that of the muscular. This comparatively slow rate of dispersion of the antitoxin, presumably into the blood or lymph streams, is usually held to be a disadvantage, and it is largely on this account that the more rapid methods of venous or thecal injection have been advocated as more suitable for treatment in the early or acute stages. To us it appears that this slow rate of absorption should rather be counted as a virtue, especially when the inoculations are made somewhere along the supposed path taken by the toxin in its journey from wound to cord. At all events, it seems clear that by these methods we could in a given area produce a zone of tissue bathed in antitoxin in far higher concentration than could be produced in the blood and lymph of the part by means of intravenous injections, except perhaps by immense doses frequently repeated. Further, it is probable that this antitoxin would remain available locally in considerable strength for a number of hours. On the other hand, assuming that antitoxin is absorbed from the muscles with comparative rapidity, this would be a reason for utilizing that channel in order to reach the nerve centres rapidly, through the general circulation, in cases where it is hoped to effect an early dissociation of toxin from these centres.

Should the wound be a single one, and especially if it is on a limb, we believe it would be sound practice to introduce antitoxin, both subcutaneously and intramuscularly, somewhere astride the path which the toxin must travel on its way to the spinal cord. To do this effectually, it would appear, if our ideas are correct, better to divide the dose and inject portions on each surface of the limb and also at different depths amid the muscles. Somewhere among these tissues we know the nerves run along which the poison is travelling and the more evenly distributed our antitoxin the better would appear the chance that it may attain effective contact with the toxin and achieve our object.

We have already mentioned that the results of these two methods of introducing antitoxin appear, in the present series of cases, to have been better than those of either the intrathecal or the intravenous methods. It may be that they would have been better still if employed alone and on the lines suggested above.

Turning now to the question of dosage, this appears a most difficult matter to judge. Cases recover in which the amount given has been almost ludicrously small, and others have died in spite of

enormous doses. It appears to be a question of bringing the antitoxin into effective contact with the toxin. There can be no conceivable benefit in flooding the body fluids with antitoxin if this never reaches the site where it is required, and, on the other hand, quite a small dose might, by acting at the right time and in the right place, do all that was needed. There are obvious limits to the amount which one can inject intrathecally, but none by the other routes. On the whole, while admitting that we have little to guide us in the matter, we think that, if the combined subcutaneous and intramuscular routes be used, the daily dosage for the first few days should not fall below 10,000 units. If it be desired to supplement this by intrathecal injections it would appear wise to limit these to such a number of units as could be contained in ten or fifteen cubic centimetres.

We are in full agreement with all that has been said on the necessity for commencing specific treatment at the earliest possible moment and also on maintaining an effective dosage well into convalescence. The present series contained several examples of relapses occurring on the cessation of serum treatment. With regard to the recommendations of the Tetanus Committee as to watch being kept for early signs of tetanus, this is obviously of the first importance. In connexion with the present series of cases we have unfortunately received little fresh information on this point. A statement upon this point is now asked in every case, but, so far, has brought little to light. Practically the only early sign mentioned has been that of local contractures at or near the wound and this has usually been followed rapidly by trismus. Some of the signs mentioned by the Committee, such as pain in the wound and hardness of the tissues surrounding it, are, we fear, too common in connexion with sepsis, gas-infection, etc., to possess as much value here as they might at home.

With the recommendations of the Committee on the subject of repeating the initial prophylactic dose of antitoxin every six or seven days as long as there is any reason to fear tetanus, we are, we need hardly add, in the fullest accord. Instructions on this have been circulated to all concerned. Again, we agree that a preventive dose should be given prior to any secondary operation. For the reasons given above we think that it would be well to give such a dose by the combined subcutaneous and intramuscular channels, inoculating it at several points around the site of operation and at different depths of muscle on its proximal side. If time permitted this should be commenced forty-eight hours before the

operation, but, if the operation was one of urgency, similar injections in the neighbourhood of the operation wound, with perhaps injection into the sheaths of prominent nerves, would appear a wise routine procedure. As far as present knowledge goes 1,500 units would be a suitable amount to give.

Non-specific Treatment.

Although really outside the purpose of the present article, we may conclude with a few remarks on the replies which have reached us in connexion with this subject. Carbolic acid treatment has been almost abandoned and few retain any faith in it. Its use was recorded in eight cases, in strengths varying from 1 in 20 to 1 in 100. In no instance were any remarks made on its favourable influence upon the progress of the case. Magnesium sulphate also has gone out of favour, only four cases having been treated by this in July, and two in September. The intrathecal route was most often adopted. Some temporary amelioration of the symptoms and control of spasm was mentioned in two cases, but paralysis of the legs, lasting twenty-four hours, was noted in another.

Sedative drugs have been used in the great majority of cases; in order of frequency these were as follows: chloral, bromide, morphia, chloretone, atropine, omnopon, scopolamine, alcohol, chloroform, and paraldehyde. In some cases, though but few, it was noted that one or other of these drugs had been useful in controlling spasm.

Although fully sympathizing with the natural desire of the busy reader to find at the end of a paper such as this a series of "conclusions," we have abstained from them, being very conscious that we have much more to learn on every point under discussion. However, we have not hesitated to express our own views on a number of these points as we have dealt with them, and we trust that they may at least serve to rouse further interest in the specific treatment of tetanus, which we believe to be of greatest value, did we but know how to apply it aright.

NEURASTHENIA AND PSYCHASTHENIA.[1]

By Colonel HOWARD H. TOOTH, M.D., C.M.G.
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In ordinary life, with or without stress, strain, or accident, in conditions of apparent health, or associated with various degrees of ill-health, we meet with a vast number of symptoms and complexes of symptoms, subjective and objective, which for want of a better name we call hysterical or functional.

So also in an Army composed of individuals of all ages and degrees of susceptibility and subject to all sorts of conditions favourable to their development, there occur an infinite variety of functional manifestations.

With this extensive series of phenomena we shall have little to do. It is better to look upon them as intrusions if they enter at all into the neurasthenic picture. They may exist separately, singly or collectively. I refer to such functional manifestations as constriction of the visual field, amaurosis, aphonia due to adductor paralysis of the vocal cords, deafness with or without mutism, functional hemi- or paraplegia, the analgesias and so forth.

I find it impossible to give a composite word picture of neurasthenia, the picture must be allowed to develop itself as we go along. To take a simple instance: a person is subjected to some sudden shock, mental or physical, without gross injury; in due course a mental state and a train of symptoms show themselves. Something has happened which has for the time being altered the whole tenor of his life, the whole man is changed. It is our business to discuss this change. It is difficult to believe that there is no physical basis underlying so grave a dislocation, and yet we have to use the word "functional" as implying that we know no such basis. Hitherto undreamt of advances in biochemistry may some day give us the light we need.

Meanwhile it may be noted that we are repeatedly coming across men who show some of the indications of Graves's disease, namely, v. Graefe's, Stelwag's and Moebius' signs, together with tremor and tachycardia, but without thyroid enlargement, a condition of "thyroidism." Possibly one or more internal secretions may be at fault in neurasthenia.

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[1] A paper read before a Conference of Medical Officers at Malta, November 24, 1916.

Neurasthenia means nerve weakness, debility of nervous origin implying lack of will power and other nervous changes, as will appear later.

Every acute disease is followed by a longer or shorter stage of debility, but that is not neurasthenia, for there need be no lack of will power, the body is too feeble to carry out the command of the will. The physical powers only are defective.

A neurasthenic, on the other hand, may be muscularly powerful, but so wanting in will power, or so prone to nervous fatigue, as to be unable to drag one foot before the other. In the one case the will is there without the power, and in the other the power is there without the will. That this is so is shown by the fact that a sudden stimulus of excitement may evoke an effort surprising in its results to the patient, and in most neurasthenics the patient can by an effort of volition force himself to perform acts beyond his apparent strength, but owing to the fatigue element this is always done at a cost.

It is therefore obvious that even in the simplest form of so-called neurasthenia, the central nervous system, using the word "central" in its widest sense, cerebral, spinal or neuronal, must be affected. And yet in these simple forms the debility is often so profound and so lasting that one is tempted to use the term myasthenia, or neuromyasthenia, suggesting that the muscular element of the neuron may possibly be predominantly implicated. This point of similarity to myasthenia gravis is, of course, purely superficial. I do not suggest a common pathogenesis.

In my succeeding remarks, and as the exuberant symptomatology displays itself, I shall have occasion from time to time to draw attention to *aspects* of the disease, aspects which predominate, but not so sharply as to allow of division into clean-cut types. These aspects help in description, and I think you will recognize the truth of them.

So in the case of the simple nervous debility one aspect is deficiency of will power, and another of chronic fatigue, a fatigue which is increased by exertion, and exertion causes an exacerbation from which recovery is slow. "I used to be able to walk ten to twenty miles with enjoyment; I can now go no more than 100 yards without real fatigue," is a common and true statement. Ordinary healthy fatigue is nervous or central, not muscular, as Waller has shown. Regular voluntary muscular efforts measured by the dynamometer and recorded on a drum, show in a healthy person a regular steady fall in power to the zero of complete

exhaustion, yet the apparently exhausted muscle reacts briskly to faradism. Compare this with the myasthenic reaction of myasthenia gravis in which faradic stimuli applied directly to muscle produce an intense and rapid exhaustion effect.

Rarely, however, is the case so simple as this; subjective and mental symptoms of great variety intrude and give rise to a bewildering series of clinical pictures. These symptoms, or stigmata, are all truly functional, having no obvious or even possible gross anatomical basis, yet intensely real to the patient.

It would appear that the most complicated subjective stigmata tend to occur in the more educated and imaginative persons, and that in the lower types the stigmata are of a simple nature, mostly of the cruder sort—pain, for instance. And the picturesqueness of the description is often inversely as the anatomical knowledge of the patient. I must say, however, that highly educated medical men occasionally attempt to explain their symptoms by anatomical descriptions which I am sure they would smile at in their patients.

A run-down hospital medical officer said: "When I bend my head forward I have a sensation in the neck which suggests that there are adhesions between the cervical cord and the theca." So vivid was this impression that it took some argument to persuade him of its absurdity. A short holiday and some strychnine completely removed it. The sensation must have been there, whatever its cause; it was the *interpretation* that was at fault, and that is what counts.

Many of these stigmata, though possibly originally simple, become extraordinarily complicated and sometimes grotesque. A lady told me that as she lay in bed she had a vivid sensation that the brain was out of her skull and lying on the pillow beside her.

I will now discuss these symptoms in some detail.

Among the most common are those referable to the head, classed by Gowers as "Cephalic Sensations."

The sensation of pain naturally comes first. The neurasthenic *headache* is conspicuously posterior or vertical as compared with that of migraine, which is frontal or temporal. It generally includes the cervical region and sometimes the whole spine. It is increased by exertion and diminished by rest. It may be described by the patient as a true pain, but more often on close questioning he will admit that the sensation is not comparable with any pain within the range of his experience; "It is much worse than a pain," and there his powers of description break down.

The cephalic sensations that fall short of that of pain, as we

understand it, are of great variety. For instance, a sense of weight, oppression, compression, internal fullness to the sensation of bursting, suggesting to the patient vascular dilatation and calling for much crude anatomical figure. Superficial sensations in the skin of the scalp suggesting worms crawling under the skin, generally referred to " nerves " supposed to be on the stretch.

Auditory stigmata are also common. Hyperacusis, abnormal sensitiveness to sounds, such as the banging of doors, street music, etc., which may excite intense resentment, this may be a temporary symptom very noticeable in shell shock cases. There may be a mental perversion, so that sounds usually pleasurable become painful and repugnant, such as music, the voice of friends, a mother unable to bear the voices of her children, and so on.

A buzzing in the ears or head is frequently complained of; it must not be confused with true tinnitus. This auditory sensation is not necessarily referred to the ears as in true tinnitus, it is more often than not referred to any part of the head rather than the ear. A patient in his desire for accuracy of description was at pains to indicate four points on the head, and to say that the point of intersection of the imaginary lines joining these points was the exact situation at which he heard the sound.

The eyes are affected in two opposite ways, over sensitiveness to light or diminution in acuity. Photophobia is sometimes intense and the patient welcomes dark spectacles, and shuns the sunlight or any bright artificial light.

On the other hand, and more frequently, there is a temporary want of acuity. Large objects may appear blurred even to an emmetrope. The attempt to read is soon followed by a fusion of the print and a sense of eye fatigue. Testing for glasses should be avoided at this stage. Congenital defects such as refractive errors, astigmatism and the like will be certain to be aggravated temporarily.

This amblyopia need not necessarily be due to constriction of the field of vision, so common a functional or "hysterical" defect, but not proper to the neurasthenic syndrome.

Tremor of the tongue or lips may impart a shivering character to the speech, sometimes closely simulating that of general paralysis. In many cases of shell shock and other soldier neurasthenics there may be profound speech defects from complete mutism to dysphonia, speaking in a whisper; these again are hysterical addenda.

Stuttering in all degrees may occur in any neurasthenic. It is a temporary symptom.

The timbre of the voice may be altered to a high pitched, almost querulous, tone. I recall the case of a lady, a rather severe neurasthenic, who spoke with a marked mincing, foreign accent, so pronounced that I thought she was French. When the excitement of the interview subsided her natural voice reasserted itself, but for a time only.

Visceral Stigmata.—The neurasthenic complains of a variety of abnormal sensations, which may be explained by an acquired abnormal consciousness of visceral movements. The patient has become morbidly alive to internal stimuli which should belong to subconscious existence, such as the heart beat, the carotid and abdominal pulses, the peristaltic movement of stomach and intestines. At first there may be only a recognition of these obtruded sensations, generally any one of them, but as they persist and as the state of anxiety grows, a simple physiological feature becomes magnified into an obsession or fixed delusion.

The most difficult stigma, however, to understand is that of chronic pain in a region such as the back or in a limb. There is a group of cases in which there is a persistent pain in, say, the whole limb for which no cause can be found, so real as to enforce an invalid existence for a period of years. I confess to having been completely baffled by some of these cases. Pain may become a delusion, a fixed idea so confirmed as to be beyond the reach of treatment by hypnotism. In dealing with soldiers we are repeatedly confronted by cases in which pain is the only symptom, and if a man for purposes of his own consistently persists in his complaint, I really know of no way in which a simulated can be distinguished from a bona fide pain, whether hysterical or of organic origin.

These allusions to subjective sensations discover another *aspect* of neurasthenia, hyperæsthesia, exaltation of sensibility of special and visceral sensations.

Muscular tremors do not necessarily enter into the picture, but nevertheless we find them almost invariably among war-worn soldiers.

Tremors of the face muscles during speech, and even in voluntary movements as in showing the teeth, have already been alluded to.

Tremor of eyelids when lightly closed is again almost invariable and I hardly think it is likely to be simulated. It is very noticeable when testing for rombergism.

Regularly spaced, persistent, coarse or fine nystagmus is a true organic sign, often of great value, as in cerebellar lesions, but

occurring also in widely diverse conditions. In some neurasthenics, however, a passable imitation sometimes occurs. It is rarely, if ever, persistent or regular. The commonest form is a slow repeated return of the deviated eyes to the middle line, due probably to the want of power of concentration on the part of the patient, so that he has to be constantly reminded that he is not looking at your finger. Some patients show a marked and characteristic reluctance to deviate the eyes, which water after two or three attempts with manifest discomfort.

In a severe case, notably after shell shock, there is a coarse or fine tremor of the whole muscular system, visible in standing and walking, such as may rarely be seen in paralysis agitans. In such a case if you lift the leg in bed by placing the hand under the knee a severe thigh clonus is evoked without added stimulus and a coarse irregular ankle clonus can be produced, which must not be mistaken for that of organic disease. There is also a marked extensor rigidity resembling at first sight the hypertonicity of organic disease of the lateral columns, but which is often, if not always, a voluntary spasm evoked by dread of the tremor. In milder cases, and in fact in nearly all soldier neurasthenics, there is a tremor of the extended hands and arms. This is so constantly looked for, and so obvious to the soldier, that one may expect attempts at simulation. The important element of this tremor picture is fine, *independent, vibratory* tremor of the fingers. A tremor movement of the larger joints, wrist and elbow, might be voluntarily imitated, but I do not think the fine, independent tremors of the fingers can; I am unable to simulate them myself. I have lately seen some excellent involuntary imitations of so-called intention tremor, such as might be seen in disseminated sclerosis.

In a disease which consists so largely of *subjective* manifestations, for the true interpretation of which we must rely entirely on the statement of the patient, we must welcome any demonstrable *objective* signs which we can make out for ourselves.

The following objective features seem to me to possess a real value as a test or touchstone of the truth :—

(1) The tremors, particularly the fine, independent vibratory tremor of the fingers alluded to above.

(2) The state of the knee-jerks. These may be normal as regards degree, even depressed, or they may be, and more often are, increased, in fact excessive. These abnormalities are of no significance however. What is important and interesting is that in very many cases the elicitation of the knee-jerk produces a

wide-spread sensation of discomfort, often excessive, but never amounting to pain.

In its milder manifestations it is often described as an electric shock limited sometimes only to the leg below the knee. But the sensation may be much more extensive than this. It may be described as causing a disagreeable shock felt all over the body, often proceeding up the spine to the back of the head and neck. It is obvious to the observer by the involuntary start that the patient gives, and he often begs that it may not be repeated.

It may be associated with a temporary more or less severe emotional disturbance, fright, tears, sometimes laughter. I have frequently seen a short-lived hysterical state follow the jerk, and in one case, a woman, it was regularly followed by a typical hysterical convulsion. Another curious point is that local stigmata, such as pain areas, posterior headache, are at the same time increased in degree for the moment.

These widespread symptoms accompany the *knee-jerk* proper, the myotatic (Gowers) stretched muscle phenomenon, not a blow on the patella or bone. They bear no relation to the intensity of jerk, though that is usually exaggerated; they are psychical and not associated, except accidentally, with any disease of an organic nature, however much the reflex may be exaggerated. In a marked case this is a very striking symptom requiring no prompting by the observer, but it may sometimes be induced or suggested in this way. The observer elicits the right knee-jerk, it appears to present no unusual features: he says, "Does that hurt you?" "No." "Does it produce any discomfort?" "No." He then proceeds to elicit the left knee-jerk, and the patient now feels the unpleasant sensations and having done so will now feel them on the right side. This is an indication of readiness to suggestion. This peculiar accompaniment of the knee-jerk was first pointed out to me by my late colleague at the National Hospital, Dr. Beevor, some twenty-five years or more ago. I have found it of great value in diagnosis and I have repeatedly demonstrated it in the out-patient room, but I have never seen it mentioned in any text-book.

(3) Persistent regular ankle clonus is a sign of some lesion, primary or secondary, of the lateral column. But an irregular clonus does occur sometimes in association with general tremors, and even without, notably after bad shell shock. There will be no extensor plantar response.

(4) In striking contrast with the tendon epiphenomenon above described is the state of certain skin reflexes. The abdominal

reflexes are generally present, and if anything brisk. But the plantar reflex is notably diminished to complete absence, and this without any true anæsthesia.

This is generally a surprise to the patient, who is often extremely apprehensive of sole tickling from past experience.

In most normal persons the sole of the foot is extremely sensitive to tickling, in many painfully so. There are persons, however, who are normally insensitive, and in some tickling is positively pleasant.

The absence of the plantar reflex in functional cases was pointed out some thirty years ago by Dr. Thomas Buzzard[1] at the time when the Weir-Mitchell treatment for hysteria was under trial.

Its value as a sign is enhanced by the fact that the sole sensitiveness is increased in most organic diseases, in fact I can conceive of no organic condition in which it could be absent except in complete destructive lesions of the posterior roots or nerves proper to that area of skin, such as may occur in coarse cauda equina lesions at the level of the first sacral root, or in severe neuritis or other lesions of the posterior tibial nerve, and possibly in some cases of tabes.

In primary or secondary lateral column lesions, disseminated sclerosis, and even complete transverse lesion of the cord higher than the sacral region, the reflex is increased.

The term "plantar reflex" applies to the gross effect of stimulation of the sole, and must not be confused with the responses of Babinski flexor or extensor.

Where such response is present it will be flexor with or without the associated contraction of the tensor fasciæ femoris, but it is more often absent together with the gross sole reflex, which gives an added significance to this sign.

I must here say that though the absence of the plantar reflex is the rule in neurasthenia there are exceptions, and I have lately seen one or two very severe cases in which the slightest touch to the sole of the foot produces the liveliest distress. A clean, sharp antithesis. As Paget says, every exception to a rule implies the existence of another which has yet to be formulated.

It is not claimed that this is a sign peculiar to neurasthenia itself. Its value lies in the fact that it is a sign of "functional" as opposed to "organic" disease.

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[1] Buzzard: "Clinical Lectures on Diseases of the Nervous System." 1882, pp. 103-117; also "On the Simulation of Hysteria in Organic Diseases of the Nervous System," 1891.

(5) A mild degree of ataxia on toe and heel progression, together with unsteadiness with eyes shut and feet in line, standing, is commonly found if looked for. It resembles the ataxia of tabes.

Psychasthenia.—I now come to consider another aspect of the subject. With few exceptions, every case of neurasthenia may be said to have a mental side. But this may predominate to such an extent as to give rise to a condition deserving of separate consideration, a state in which the more physical stigmata are absent or in abeyance, and the psychical or mental dominate the picture. This has received the name of "psychasthenia."

The mental attitude of the psychasthenic is that of depression, more or less profound, with an underlying aspect of fear and apprehension of undefined evil. There is fear of the present, of failure, of mental breakdown, of the future which colours and disturbs the mental perspective, so that the mind resembles a bad picture, with an ugly ill-balanced background. Among these fears that of death does not usually figure. The idea of death as an end of the state of misery is not unwelcome. The patient becomes introspective, self-centred, looking for and almost inviting symptoms. A minor degree of this state is that of continuous unreasonable anxiety associated with a sense of epigastric uneasiness.

Suicide is sometimes talked about freely, but more as a form of apprehension and as a mode of conveying to other minds the misery of the patient.

Delusions and the suicidal and homicidal impulses do not enter the psychasthenic picture.

The patient may lose all interest in his business; the once keen officer says: "I am absolutely sick of the sight of a soldier," and yet there may be no falling off in acuteness or accuracy. The aspect of fatigue is here as in the neurasthenic, but it is a mental fatigue.

Another common minor shade of the mental state may be described as that of intense boredom, too bored to read a book, or to keep up a conversation, or to meet people. Irritability is generally freely admitted. A symptom which causes, not unnaturally, great alarm is an actual loss of memory for the ordinary affairs of life. It is remarkable how severe this may be and yet pass off with recovery.

A very serious feature in the case of officers of all commands is an intense reluctance to take responsibility, a form of moral cowardice, and a source of great distress to the sufferer. This is sometimes so acute that the patient is tormented by doubts

as to possible consequences on signing the most ordinary routine documents. Insomnia is a constant and early symptom, in fact enforced broken rest is no doubt a sufficient cause in itself for a breakdown. There may be for a time no sleep at all, but a long night of anxious foreboding. More often the patient goes to bed tired out, gets off to sleep at once, and then wakes up, perhaps with a start, in any time from half an hour to two or three hours afterwards, to lie awake until the early morning. Or more commonly, after a night of poor sleep, sometimes, but not always, tormented by dreams, he may wake about 5 a.m., suffering from the depths of depression, to rise as tired as when he went to bed. Some evil influence colours his whole life and yet there may be no physical symptoms, subjective or objective. The nutrition may be maintained and the more tangible stigmata of neurasthenia may be absent.

This state may be continued for long periods, months even, but generally with intervals, marked by a sense of surprising unexpected well being. These intervals, short at first, may follow a good dinner or the use of stimulants, in fact the "bien aise" of alcohol is to be guarded against.

The periods of remission tend in a favourable case to become longer and those of depression shorter as the case progresses towards recovery.

It must not be forgotten that this state may be the precursor of true insanity, melancholia and general paralysis, in which case it is symptomatic. Pure psychasthenia is not so common among the lower ranks, but unfortunately occurs frequently amongst officers. The features above described enter to a greater or less degree into the complex of neurasthenia.

Classification.—The difficulty in presenting a comprehensive word picture of neurasthenia lies in the vast scope and association of the symptoms and the aspects from which it can be viewed, especially in a short communication like this. I now propose to attempt a short summing up, a grouping of the aspects and stigmata by which certain groups, scarcely worthy to be called prevailing types, may emerge. Whether this can usefully be done I must leave to your judgment.

Group I.—The predominant symptoms are physical: the key-note is fatigue. This fatigue is physiologically nervous, probably central, but the superficial resemblances to myasthenia gravis seems almost to justify the use of a term such as neuro-myasthenia. There will be no mental or psychical stigmata beyond feebleness of will power.

Group II.—This comparatively simple picture is now enriched by a great number and variety of symptoms, subjective and objective, namely:—

(*a*) *Subjective.*—Pains, headache, etc. The aspect of hyperæsthesia of the senses, hyperacusis, tinnitus, photophobia. Exaltation of and intrusion in consciousness of movements of internal organs which may be physiologically sound, such as the heart and great vessels, the abdominal organs, etc., visceral hyperæsthesia.

(*b*) *Objective.*—Muscular tremor, general, with or without spasm, fine vibratory, and independent of fingers. Pseudo-nystagmus, ataxia, and rombergism. Characteristic knee-jerk epiphenomenon. Absence of plantar reflex.

To both of these sub-groups may be added any of the well-known hysterical stigmata, but they are additions not strictly belonging to the picture.

As in Group I there need be no mental symptoms, though such a clean distinction is not common, and, perhaps, almost pedantic. If such a type as this is permissible, it may be called "neurasthenia" proper.

Group III.—To the above groups, together or singly, may be added any or all of the mental stigmata of psychasthenia. This is the largest and most comprehensive group of all into which most of the cases called neurasthenia fall. For the purposes of this classification we may call it "psycho-neurasthenia."

Group IV.—Psychasthenia is a distinct entity, a purely mental state, presenting the following aspects: Depression with fear and apprehension, loss of memory, grasp of affairs and power of attention, irritability, introspection, reluctance to accept responsibility.

Causation.—In civil and military life a more or less obvious cause can generally be assigned, but not always, and speaking generally the more definite the cause the better the prognosis.

Neurasthenia occurring spontaneously may be symptomatic of underlying or impending mental disease.

Certain temperaments predispose to neurasthenia. Persons who have all their lives taken life very seriously, themselves especially, feel all the emotions acutely, are often amongst the most lovable, and even as neurasthenics excite respect. Many are naturally subject to moods varying in degree from elation to depression, from day to day, and even from hour to hour.

Innate selfishness is much too common a temperamental feature, though often concealed under happy and easy conditions

of life. The self-centred, introspective attitude is sometimes as much a surprise to the friends as it is to the patient.

Mental degenerates, sometimes brilliant in academic attainments, of good impulses, but nevertheless unstable, and wanting in judgment and sustension of effort, easily break down under strain. Many of these are serving in all ranks.

The abuse of alcohol as a predisposition needs no comment.

Another predisposing condition is malnutrition and simple loss of body weight. In civil life this is a very subtle question, but in the conditions of military service it is more easy to understand. A loss of body weight caused by improper food, faulty assimilation from whatever cause, diseases, notably dysentery, in some temperaments strongly favours a neurasthenic breakdown, and its successful treatment by diet and rest may be followed by results surprisingly rapid and permanent in young subjects.

Age is a relative term, not to be too strictly measured, as Hughlings Jackson used to say, "by the number of revolutions round the sun"; yet we must not forget that the power to bear responsibilities under service conditions does not improve with age, and stress operates with great effect on the older men.

The most obvious and direct causes of neurasthenia and psychasthenia come under the general terms *stress* and *shock*.

These two causes may be accessory one to the other, that is, an apparently inadequate shock may owe its severity to a long preparatory stress.

(1) *Stress* connotes a prolonged mental strain. Its effect as regards rapidity of onset and severity depends upon predisposing circumstances, temperament, general health, etc.

This strain is practically always psychical; it is doubtful whether prolonged exertion of the purely physical kind can produce by itself the neurasthenic picture in any *healthy* man without these predisposing circumstances.

But combine over exertion with the constant sense of responsibility and loss of proper sleep in the case of the officer, together with the ever present possibility of death, even if not consciously admitted, the loss of comrades and the eternal clamour of the shells common to all ranks, and sooner or later the most stable mental equipment may give way. Indeed, it speaks well for the mental stability of the British soldier that there are not five times as many neurasthenics as there are.

A large number of the victims of stress received here are non-combatants, on lines of communication, or at the base, clerks,

mechanics, and quite a number of the Labour Section Army Service Corps, who have never been at any time near the firing line. Most of these are men who are unfitted by temperament, training, and age, to bear any extra strain. Most of them have lost weight, whether or not after some disease, such as dysentery.

(2) *Shock* connotes some event which, though it may be accompanied by bodily violence, is yet essentially psychical, in that there may never be at any time any evidence of organic lesion.

The physical cause may seem in some cases inadequate to produce so serious a sequel, and in many cases it would be inadequate if it were not for a train of predisposing circumstances.

We are all familiar with the so-called traumatic neurasthenia following, say, a railway accident, in which the symptoms declare themselves some three or four days after the event.

Shell shock differs from ordinary traumatic neurasthenia in some important particulars. There is a violence, a commotion and evolution of poisonous gases in connexion with high explosives which, as Mott has suggested, may have much to do with the immediate cerebral symptoms, loss of consciousness and epileptoid convulsions, for instance. It is possible that this "commotio cerebri" is the result of actual disorganization of brain tissue, or perhaps multiple punctate hæmorrhages. Moreover, there are other circumstances peculiar to shell bursts, burying under debris, loss of comrades and so on, which add horror to the situation.

These special circumstances may account for the early appearance of the neurasthenic phase, and the absence of the latent period referred to above; patients say that their troubles began immediately on recovering consciousness.

Nevertheless, the ultimate picture is that of traumatic neurasthenia writ large; the severest of all shocks, in which the psychical element must obtain in the highest degree, followed by the most pronounced psycho-neurasthenic state, and the most severe added hysterical stigmata, deafness, mutism, blindness for instance, such as we rarely see in the traumatic neurasthenia of civil practice.

One might say that neurasthenia in its fullest development is almost rarely associated with obvious tangible injuries or wounds. This is so constantly observed as to be more than fortuitous. The reaction on the mind of a wound or injury, with its care, enforced rest and treatment, seems to have a salutory effect, and though certain minor hysterical stigmata, anæsthesias, for instance, may co-exist, the full psycho-neurasthenic picture rarely develops

A wound has the effect of diverting the mind from introspection, it offers a satisfactory explanation for all symptoms, hope of ultimate recovery, the kudos of honourable wounds and in civil life the certainty of compensation, perhaps all tend to an attitude of mind unfavourable to the establishment of the neurasthenic state.

An injury is a mental counter irritant. I can suggest no better explanation of what is a well-known fact.

Prognosis.—Generally speaking, in civil experience, a nervous breakdown runs a course roughly of a year's duration, or thereabouts.

I do not mean that the patient is seriously affected for the whole of this period, but that he cannot expect to be free from some manifestation or other for much short of it, and in some cases it may be much longer. A man may never again be fit to assume great responsibilities. Happily these cases are, on the whole, rather exceptional. The periods of depression of the psychasthenic become shorter and the remissions longer until the normal has become established. These remarks apply to many of the cases of soldiers of all ranks, and it is likely that a considerable percentage of the officers affected will be unfit for commands in the field, and especially for the nerve-wracking duties of aviation, for the rest of the War.

On the other hand, I have been much impressed by the rapidity and thoroughness of the recovery of many young men after the most serious and unpromising train of symptoms. Mere wrecks, mental and physical, I have seen coming from France, sleepless, unable to bear the slightest sound, or the sunlight, afraid of their own shadow, and yet after a week or two of quiet and rest practically on the road to recovery, and in about two or three months able to rejoin. It is rare to see such rapid recoveries in civil practice. Perhaps they would be commoner if they had always been taken seriously from the beginning.

Healthy young men of clean personal and family history bear severe strains, physical and mental, better than older men, though the strain and stress to which they are subject in this War exceed in severity any that are likely to occur in ordinary life; provided there is no mental heredity or acquired taint, they regain normal conditions with unexpected rapidity.

But men of more advanced age, say 40, and especially alcoholics and mild mental degenerates, having once broken down require long periods for recovery, if they ever do recover completely. It will probably be found also that the apparently simple "stress" cases are really more complex and will be longer and more

permanently unfit than the initially more serious "shock" cases, for the reason that having broken down under less severe circumstances they are usually weaker types of men. But of course every case must be taken on its own merits, the past and family history, temperament, etc., having been duly considered in forming a prognosis.

Treatment.—To gain the confidence of the patient at the outset is more important in this disease than in most, or any other. This is not always an easy thing to do, but without it we fail. Whatever opinion we may hold as to the value of direct methods of suggestion, I maintain that if any straightforward medical man can gain the complete confidence of his patient, he can and does influence the patient in the way of suggestion. I am sure that a large number of patients date their steady recovery from a prolonged and careful examination, a commonsense explanation of the condition, an assurance that organic diseases may be excluded and a confident prognosis with no attempt to minimize the gravity of the state, the reality of the symptoms, or the length of time necessary for the recovery.

It takes quite a long time to make a detailed neurological examination of exclusion, and longer still to listen to the patient's account. We owe it to the patient to make it, for no man can say what may underlie this complex of symptoms without it; the patient is fully alive to the importance of it and it is the first step in the treatment. Another point, and one repeatedly missed by medical men, is to allow the patient full time to detail every symptom, physical or psychical, and not to attempt to pronounce on the case until the last word has been heard. It is the only way to reduce some patients to silence. Also to receive every statement, however grotesque, with sympathetic gravity, remembering that such statements are not grotesque to the patient, nor would they be to us if we knew all. It is our duty to straighten out a distressed, confused mind, and a chance expression easily missed in a hurried examination frequently throws a flood of light on the mental state. All this takes time and it is time exceedingly well spent. There is no pretence or sham about it, it is good, honest work, it is essential and it is how we would wish to be treated ourselves. Most psychasthenics have in the back of their minds one or two great bugbears, "paralysis"—an indefinite term full of terror to the uninitated—or insanity, a still greater horror. These are repeatedly kept in the background as too terrible to mention. I never omit to ask "What are you afraid of, do you think you are going to be

paralysed, or go mad?" and it is almost amusing to see the relief when this dreadful question has been discussed and dismissed with every reassurance.

I need scarcely say that anything like ridicule is not only unkind, but worse than foolish.

You remember the "Rime of the Ancient Mariner" who shot the albatross :—

> "Oh shrieve me, shrieve me, holy man!"
> The Hermit crossed his brow:
> "Say quick," quoth he, "I bid thee say—
> What manner of man art thou?"
>
> Forthwith this frame of mine was wrenched
> With a woful agony,
> Which forced me to begin my tale;
> And then it left me free.
>
> Since then, at an uncertain hour,
> That agony returns:
> And till my ghastly tale is told,
> This heart within me burns.
>
> I pass like night from land to land;
> I have strange power of speech;
> That moment that his face I see,
> I know the man that must hear me:
> To him my tale I teach.

Only in this case the listener was not a sympathetic doctor, but an unwilling and hungry wedding guest.

As to the general treatment we must be very sensitive to mental indications.

The state of nutrition, body weight, is a very helpful guide to treatment.

Persons temperamentally predisposed to nervous breakdown begin to show symptoms as soon as they lose weight, even to so slight a loss as half a stone. This is the condition of most of our soldier patients: due to improper feeding, imperfect mastication, bodily wear and tear, or disease such as dysentery or even latent malaria. This class of case is, on the whole, the most satisfactory to treat. Massage and generous feeding on the old rest cure lines may be followed by rapid recovery.

The inclinations even of the patient may guide us quite usefully. If he takes kindly to and welcomes the idea of seclusion and rest in bed, it will probably be found to be the right course, and it should not be of less duration than a month or six weeks. The rigours of the old Weir-Mitchell treatment are never, in my opinion, justified in this class of case.

But when a man is well nourished and, as often is the case, intensely averse from a course on the lines suggested, this may be

quite the wrong treatment. Massage is probably unnecessary, though it may not be actually harmful, but rigid seclusion and even enforced rest in bed seem in such cases to produce or foster unexpected mental states. I have seen cases brought to the border line of insanity by a rigid routine of this kind. Such cases are best among their friends or even lightly employed.

A period of complete idleness is grateful and beneficial to some minds, positively harmful to others. There are men and women who are possessed of no resource, mental or bodily. Take them from their routine work and they are miserable. They do not read, they have no hobbies, no amusements and play no games. I have met many who have not a friend in the world and have never had one. What is the sense of telling such a person to take a holiday? he does not know how to set about doing it. These are among the people who gravitate to "hydros," and certainly afford one justification for the existence of such institutions.

Many a business man has been ruined mentally by such advice, he does not know how to be idle, he only tends to become more and more introspective. Let him go back to his work on a low scale, ever so little, and in doing so he keeps his self respect, and the neurasthenic phase, for a phase it is, will eventually pass. Work in this case is part of the treatment, paradoxical though it may appear. These remarks apply strongly to the cases of some officers, and even men.

Happily these are exceptions, most of our patients may be trusted to make the best use of a period of rest and idleness.

A real danger, however, to some active minds is that they may overdo their amusements. You cannot bluff neurasthenia. Long walks, too much golf and tennis, late hours at bridge, with the idea of shaking off "nerves" invite trouble and delay recovery. There still survive doctors who give the silly advice—"Buck up, take plenty of exercise, its only 'nerves.'"

Symptomatic Treatment.—*Hypnotism* is a treatment of stigmata, and not of the state that produced them, or on which they are grafted. This treatment may almost miraculously remove stigmata and so contribute to recovery, but the neurasthenic phase must run its course.

Insomnia calls for treatment urgently. Good nights are followed by good days. Rarely, if ever, should opium in any form be used for pure insomnia. Trional or veronal given not oftener than every other night are generally the most useful and should rarely be used for more than a fortnight. Bromide ten grains and tincture of

digitalis five minims in three doses repeated at half-hourly intervals is very useful where there is subjective pulsation in the vessels.

Headache may be treated by aspirin, valerianate of zinc five grains, phenacetin "et hoc genus omne."

Electricity must be used tentatively. Faradism seems to be of little use. Galvanism in the form of baths has a stimulating effect in some and soothing in others. So also if applied locally to the neck for the characteristic headache. High frequency currents are very varied in their effect.

The late Dr. Lewis Jones, an accomplished electro-therapeutist, used to say that the state of the blood pressure gives some broad indication as to the use of electricity, in that neurasthenics with a low blood pressure usually took kindly to it and derived benefit, whilst those with a high meaning pressure seem to be the worse for it.

Alcohol has an almost magical effect in the depressed periods of psychasthenia. It is therefore to be used with much discretion. As a routine it is perhaps better to rely on some general tonic and the most generally useful is strychnine.

In conclusion, I must anticipate a probable criticism, namely, that my remarks are based largely upon civil experience and at the present time it is the military that is wanted. That is so, but I must repeat that I have up to now learned practically nothing new from soldier cases. I have seen the counterpart of most of them times and often at home. Even such "shell shock" cases as I have met with, and read of, seem, in their most important general characters, to differ from the severe traumatic neurasthenia of civil life more in degree than in kind. As I am not a psychologist, I have used the language of, and tried to handle the subject as, a practical physician.

From being at first, and even now perhaps, looked upon askance by military medical officers, neurasthenia is now in danger of being overloaded, so that every man who has a functional symptom or two, which might be cured by hypnotism, or electricity, may be sent home unnecessarily labelled with that formidable diagnosis.

My object has been rather to constrict the field than the reverse, and by attempting to define its limits and the true stigmata of the disease to help towards such an understanding of it, that the real neurasthenic may be justly appreciated on the one hand, and that the Army may not be unduly depleted on the other.

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F.* (*January to August*, 1916).]

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PART II (*continued from p.* 187).

(10) *Lamblia intestinalis*—*Reproducing Forms.*

(Plate II, figs. 1 to 5.)

It was suggested by one of us (C. M. W.), who had made observations on these flagellates both in man and animals during a period of many years, that *L. intestinalis* possibly multiplied only in the encysted stage. This suggestion was put forward because free dividing forms had been constantly looked for, but never found even in animals which were killed and examined for the purpose. It was perfectly understood that this view was at variance with what we know of other intestinal protozoa, but as *L. intestinalis* is a parasite of the small intestine, it was thought that forms which encysted high up in the gut might still be liberated under the action of the pancreatic juice a little lower down when division within the cyst had been accomplished. In his criticism of this view (*British Medical Journal*, June, 1916) Woodcock seems to forget that lamblia lives in the small intestine, and that in order to reach the pancreatic fluid there is no necessity for the cysts to escape from the intestine and be swallowed by the same or another host, as must be the case with protozoa which live only in the large intestine.

The rarity of dividing forms in the stool may be due to the distance of the lamblia from the rectum, but Woodcock offers no explanation of the fact that direct examination of the small intestine of infected animals fails to reveal dividing forms, nor does he tell us if he has searched for them in this situation. One would naturally conclude that dividing forms existed, and it was only with reluctance after many fruitless searchings that another view was put forward. It still has to be proved that the view is incorrect, though observations we have recently made on the case to be described now show that, at any rate under certain conditions, lamblia may divide as a free-living flagellate.

A patient was admitted to hospital with diarrhœa and the passage of large quantities of mucus. Examination of the stool revealed lamblia in enormous numbers, the mucus portion of the stool being simply packed with free-living flagellates. The patient was also a carrier of *Entamœba histolytica*. Films were fixed in Schaudinn's fluid and stained with iron hæmatoxylin. The lamblia were beautifully preserved, and examination of the stained films showed all stages of undoubted binary fission. The dividing process, as illustrated in the figures (Plate II, figs. 1 to 5), could be traced from the commencing division of the nuclei to the completion of longitudinal splitting of the flagellate.

In this process the whole complicated system of sucking disc with its related flagella is reproduced on the dorsum of the flagellate, but the tracing of the details of this process is a very difficult matter which is only to be compared with the difficulty of following the division in the encysted forms. When the whole flagellar apparatus has been duplicated the subsequent division can be readily followed, and is so clearly illustrated in the figures that little description is necessary. Apparently the flagellate splits longitudinally, the fissure passing in between the sucking discs from before backwards. Before this takes place the complete apparatus of the new flagellate is reproduced. The final stage is seen where two flagellates are attached only by the tapering posterior extremities.

Division of the flagellates had evidently been taking place with rapidity, for there was a very great variation in the size of those present in the film. There were present flagellates showing every gradation in size, from large forms measuring 17 by 10 microns to smaller forms measuring 10 by 6 microns. In some parts of the film streaks or patches of mucus occurred which were packed with these small forms, while in other places the mucus contained

only large forms. The small flagellates had the same structure as the larger ones, except that the sucking disc appeared to occupy a greater portion of visible surface of the flagellate. There was no tendency for these small forms to take on the octomitus structure, so that there is no reason to assume, as some have done, that the lamblia is a later stage in the development of octomitus. An octomitus of man has recently been described by Chalmers and Petskola in the Sudan. Kofoid and Christiansen have recently described binary and multiple fission in the lamblia of mice (*Proc. Nat. Acad. Sci.*, November, 1915).

As regards the cysts of lamblia we have little new information to offer. In certain cases where the cysts had apparently been formed only recently, judging by the thinness of the wall and the fact that they had not yet assumed the perfectly ovoid form so characteristic of the mature cyst, the single lamblia within could still be seen moving its posterior extremity slightly from side to side, while the central pair of flagella were undulating slowly as one often sees them in lamblia which have ceased to swim about actively. At a later stage the cyst becomes more accurately ovoid and the wall tougher, while the single lamblia within may or may not have divided. We have not obtained any evidence in support of the view that the cysts are formed to enclose two conjugating individuals. Whether such cysts occur or not is still undecided, but it is perfectly clear that the majority of the cysts are formed round single individuals.

(11) *Course of Lamblia Infections.*

It has already been shown that lamblia infections may persist for several years, but during the course of such an infection the flagellates or their cysts are not always to be found in the stools. The cysts alone are usually found, and judging by these the infection fluctuates, there being periods when the cysts are very numerous and others when they are absent. We do not know whether this absence of cysts from the stool means that the flagellates in the small intestine are reduced in number, or whether there has been a sudden cessation of cyst production. Nor do we know the cause of this change. In watching the lamblia infections from day to day a case, which has been passing a + + + infection of cysts regularly for a fortnight or longer, will suddenly show a reduction to + +, then to +, and then entire absence of cysts. Just as suddenly after an interval of a week or more a few cysts will be found and the infection will work up again to a large one. The

course of several lamblia infections are shown in the charts illustrating the cases of *E. histolytica* and flagellate infections accompanying this paper.

Pathogenicity of Lamblia.—Of all the flagellates of the human intestine lamblia has the best claim to pathogenicity. This does not mean that it always produces symptoms, nor that every one with such an infection is to be isolated and treated as a dangerous carrier. Such a course would be obviously absurd in time of war, for there occur many healthy, able-bodied men who are carriers of lamblia for every one who shows symptoms or is incapacitated in any way by its presence.

The reasons for regarding lamblia as pathogenic are not merely the presence of the flagellates in diarrhœic conditions, but the fact that certain cases of lamblia infection have attacks of a characteristic nature when they pass large quantities of yellowish mucus in which occur unencysted lamblia in myriads. A small portion of such mucus may show the flagellates lying over one another and filling the entire microscopic field. Such attacks of diarrhœa with mucus occur at intervals, and whenever the attack comes the same mucus is passed with the same microscopical appearances. A case of this kind was described by one of us (C. M. W.). A man had repeated attacks of this kind during several years. It is difficult to explain the presence of the large quantity of mucus on the occasions of the attacks, and above all the crowding of the mucus by the flagelletes without assuming that the mucus must be produced by the intestine at the site of the lamblia infection and that the flagellates are directly responsible for its production. We thus have much more proof of the pathogenicity of lamblia than in the case of either trichomonas, tetramitus, or any of the rarer flagellates, all of which are most usually encountered in diarrhœic conditions in which mucus production is not generally a feature of the case.

(12) *Tetramitus mesnili—Free and Encysted Forms.*

(Plate II, figs. 6 to 18.)

This flagellate is of very common occurrence and has been more frequently found since we have been able definitely to recognize the encysted form which is at times the only stage met with in the stool.

Now that it is being generally recognized, the flagellate will undoubtedly prove to be of world-wide distribution. It has certainly often been mistaken for trichomonas and possibly other organisms,

though attention to details of structure should prevent any such errors in the future. One of us (C. M. W.) has noted tetramitus in iron hæmatoxylin stained films of fæces from the Philippines and Panama, two places from which the flagellate has not hitherto been recorded. In these places the flagellate must have been seen and described under other names. The flagellate is typically pear-shaped, though very frequently it is somewhat flattened or even leaf-like, while the long-drawn-out flattened posterior extremity may be twisted and folded in a variety of ways to produce peculiar grooves and spiral turns. The figures represent some of these twisted forms which are so common that they can hardly be called abnormal. (Plate II, figs. 6 to 9.)

It seems most probable that *Tetramitus mesnili* multiplies as other intestinal flagellates by binary fission, but we have not yet met with the dividing stages.

We have, however, been able definitely to recognize the encysted forms of this flagellate, and these are of importance because an infection can be recognized by them just as a lamblia infection can be identified by the presence of its cyst in the formed stools from which the flagellates are usually absent.

The cysts of *T. mesnili* were first described by one of us (C. M. W.) in the original description of the organism. The cyst was there depicted as a small oval structure very much like a small lamblia cyst, within which could be detected the nucleus and cystostome of the flagellate. Though this type of cyst occurs not infrequently, the commonest cyst is distinctly pear or bottle shaped with one end narrower than the other as shown in the figures. This type of cyst was figured by Prowazek and Werner in a paper describing some tetramitus infections met with in Hamburg (*Arch. für Schiffs. und Tropen-Hyg.*, Bd. 18, 1914, Beiheft 5, Festschrift).

As seen in fresh preparations the pear or bottle shaped cysts are pale bodies which show no internal structure except two or three, rarely more, small refractile, greenish granules (Plate II, figs. 10 to 12).

They vary in length from seven to ten microns and sometimes occur in such large numbers in the constipated stool that several can be seen in every field of the one-twelfth objective. The recognition of the cysts in the fresh condition is sometimes rendered difficult on account of the presence of a yeast of similar shape. The yeast, however, shows clearly its internal structure of granular cytoplasm with large vacuole, the whole being much greener than the pale structureless tetramitus cyst. The yeast varies in shape

more than the tetramitus cyst and the characteristic budding forms are to be found if one looks for them (Plate II, figs. 16 to 18).

The tetramitus cysts stain readily by the iron hæmatoxylin method after fixation in Schaudinn's fluid, and when suitably differentiated they show the characteristic nucleus and the cytostome rim (Plate II, figs. 13 to 15). One or more granules are present near the narrow end of the cyst and the deeply staining line which borders the cytostome takes origin in one of these. In addition one can sometimes make out the flagellum, which normally lies within the cytostome also arising from this granule. Further than this little structure can be detected and we have not seen any indication of nuclear multiplication. The four-nuclear cyst figured by one of us (C. M. W., *Lancet*, November 27, 1915, fig. 17, and JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, December, 1915, fig. 17, p. 614), as a possible later stage in the development of the tetramitus cyst, has turned out to be the cyst of *Entamœba nana* described below and not a cyst of the flagellate.

(13) *Course of Tetramitus Infections.*

On account of the characteristic cysts it is much easier to control a tetramitus infection than one of trichomonas. On those occasions when the flagellates are absent from a formed stool their presence in the gut is still detected by the pear-shaped cysts which escape in the fæces. Though like trichomonas, tetramitus tends to be present intermittently in the stool, this feature is not nearly so marked. In case Howard, for instance, the flagellate was present practically continuously for over fifty days. In another case, Gildel, it was present for ninety-one days, being absent only for about a month at the middle of the observation owing to treatment by emetine orally administered. A glance through the cases of *E. histolytica* infections illustrated in the tables at the end of this paper will show how the tetramitus infection persists, and though it may disappear for a time it reappears again later. As such an infection can persist for over three months it must do so for longer periods, though we have not the same data as we have in the case of the lamblia infections, which one of us (C. M. W.) has already shown to be able to persist in the intestine for several years.

(14) *Trichomonas intestinalis and Trichmonas in the Mouth.*
(Plate III, figs. 18 to 23.)

The general structure of this flagellate has already been described by many observers, and it has been pointed out that the number of flagella is either three (trichomonas), four (tetratrichomonas),

or five (pentatrichomonas). The commonest type seen by us has been the tetratrichomonas (Plate III, figs. 19 to 23), though three and five-flagellar forms (Plate III, fig. 18) have been seen, each on one occasion. Apart from the flagella the three types show no variations in structure, though a peculiar difficulty in the making of satisfactorily stained films of the human intestinal forms renders their study somewhat tedious. Very good preparations showing the main features can be made by exposure to osmic vapour of the wet film, which is then dried and stained by eosin azur. A good method is to expose a small drop of saline emulsion of fæces on a slide to the vapour of the osmic acid bottle for about ten to twenty seconds and then to be spread out thinly, dry and stain. It will be seen that all three types possess definite axostyles, the presence of which in the human intestinal trichomonas some observers seem to doubt. For instance, the figures given by Brumpt in his "Précis de Parasitologie" (p. 195) do not show axostyles. The structure, though most readily seen in the osmic vapour films, can, with careful examination in well differentiated films, be made out in iron hæmatoxylin preparations fixed in Schaudinn's fluid. As in other trichomonas, the axostyle appears to take origin in the neighbourhood of the basal flagellar granule. The structure of the undulating membrane with its attached flagellum and the basal supporting fibre call for no special remarks. In sublimate-fixed films the nucleus appears spherical with a fine nuclear membrane and centrally placed karyosome. The trichomonas in the human intestine are rarely above ten microns in length so that their study is very difficult.

We have made most careful search, in a number of cases followed from day to day, for encysted forms, and though we have several possible structures in mind we have come to no definite conclusions on the matter.

It would seem that encysted forms must be present at some time or another, for we now know that all the common protozoa of the human intestine have such stages.

In one case (Morris) which was being controlled daily on account of *Waskia intestinalis* infection, *Trichomonas* sp. was found in the mouth along with entamœbæ in a pyorrhœa exudate. The case had been most carefully watched for many weeks and at no time were trichomonas found in the stool. The mouth trichomonas persisted, so that the patient must have constantly swallowed the flagellate, yet no intestinal infection was established. This observation would seem to suggest that the mouth trichomonas

differs from the intestinal form as the mouth entamœba does. The mouth trichomonas in this case had three flagella and possessed a definite axostyle. Though the patient had a gut infection of both waskia and tetramitus, these flagellates though specially searched for were never found in the mouth.

(15) *The Course of Trichomonas Infections.*

In a former publication (*Lancet*, November 27, 1915) one of us (C. M. W.) wrote that trichomonas infections did not appear to be of very long duration, as the flagellates quickly disappeared from cases under observation. We have had in Egypt a better opportunity of studying the flagellate infections and it is quite evident that a trichomonas infection may persist for long periods, the parasites, however, only being present in the stool intermittently. They are present perhaps for a week and then disappear only to return later. The difficulty of controlling such an infection is all the greater as encysted forms are not known. With lamblia and tetramitus for instance, infection can be recognized by identifying the encysted forms when the free forms are absent in the constipated or formed stools. With trichomonas, on the other hand, one very rarely finds evidence of infection other than in the soft unformed or liquid stools. Apart from the intermittency of the infection dependent on the character of the stool, there seems to be a real one when flagellates may be absent for days together even when the stools are quite soft or liquid. In one case (Howard) trichomonas was present practically continuously for over three weeks, when it vanished not to reappear during the following three weeks. This was the longest period we have observed of the continued presence of trichomonas in the stool. In another case (Pointer) trichomonas was only absent for a few days at a time during an observation of sixty-two days.

(16) *Pathogenicity of Trichomonas.*

As already explained, this flagellate is hardly ever found in any but soft or liquid stools, and it is this reason which has led observers to regard it as pathogenic. It is quite possible that sometimes a flagellate produces symptoms of diarrhœa resulting from an irritation produced by large numbers of organisms, but we are convinced that in the majority of cases of diarrhœa its presence is only accidental, and that it is fixed upon as the cause of trouble because it happens to be the most conspicuous organism in the stool. In an examination of 263 hospital cases where the stool was liquid,

trichomonas was only found in eight, while of 393 with soft, unformed stools it was found in fourteen, and in 165 stools consisting of blood and mucus it was found in three. There is very little difference in any of these figures, though they are distinctly higher than the findings in healthy men given in an earlier part of this paper. This is only to be expected when one remembers that the percentage of liquid and soft stools among the healthy men is much lower than amongst the hospital cases. In the cases which had blood and mucus in the stool the trichomonas was certainly not the cause of the dysenteric symptoms, yet the liquid and soft stools did not show a definitely higher proportion of trichomonas cases. From these figures there is to be gathered nothing which will support the pathogenicity of trichomonas. In warm countries where practically every incoming white man suffers from periodic attacks of diarrhœa either from indiscretions of diet, exposure, or other causes, it is not surprising that trichomonas should occur in some of these. It is, however, obviously illogical to call all such cases of trichomonas diarrhœa, while there is no excuse whatever for the use of the term "trichomonas dysentery." The cases of dysentery in which trichomonas has been present have been cases of bacillary dysentery.

We are of the opinion, therefore, that while trichomonas may in some cases cause diarrhœa, and possibly a diarrhœa persisting over several months, in the vast majority of cases in which it has been found it has in no way been the cause of trouble. Those who are inclined to attribute to the flagellate a pathogenicity must never forget that there are hundreds of cases of diarrhœa both transient and chronic in which no protozoa whatever are to be found for every one in which trichomonas is present. The inclination to attach importance to it as a pathogenic agent is the direct outcome of its size and structure.

(17) *Coccidium* (*Isospora*).

As we have already mentioned, the isospora which one of us found fifteen times in the examination of 556 cases in London during the latter half of 1915, was found only once amongst the large number of men examined by us in Egypt during the first six months of 1916. It seems probable that the infection came from Gallipoli.

The single case (Webber) seen by us in Egypt was in an *E. histolytica* carrier who had been discovered as such in the

routine examination of men in Sidi Bishr camp. The man was brought into hospital for treatment of his *E. histolytica* infection and the first oöcysts were seen on the eighth day that the stool was examined and on the day that a course of one-grain emetin injections was commenced. The twelve injections of emetin did not rid the man of the coccidium infection any more than of the *E. histolytica* infection. The oöcysts of the coccidium were few in number during the first few days of the course, but they became more numerous towards the end and were still more numerous after the course was finished. Nine days after the completion of the first emetin course a second course was given. This time the double treatment of injections and orally administered emetin (1½ grains a day) was employed. The oöcysts became fewer and were last seen on the sixth day of the course, the *E. histolytica* having vanished after the second day. The case was most carefully controlled for a month after treatment, several films being frequently examined but no recurrence of the oöcysts occurred. The treatment seemed not only to have cured the patient of the *E. histolytica* infection but of the coccidium infection as well.

As regards the pathogenicity of the coccidium nothing can be gathered from this case, for though there was also an *E. histolytica* infection there were no symptoms attributable to either. The patient had been on the Peninsula, where he had had dysentery, and if the coccidium infection had been contracted there he must have carried it for seven months, as he had left in September, 1915.

As regards the oöcysts from this case, development was easily obtained, many of them completing their development in twenty-four hours. Some of the oöcysts showed a peculiar tendency to abnormal development in producing only a single sporocyst containing eight sporozoites. Developed oöcysts were given in large numbers to a young mouse but no infection occurred. Kittens fed on developed oöcysts also failed to become infected. The isospora of cats is very common in Alexandria, but the oöcysts are quite unlike those of the isospora of man.

(18) *Iodine Cysts* (*I. Cysts*).
(Plate III, figs. 12 to 17.)

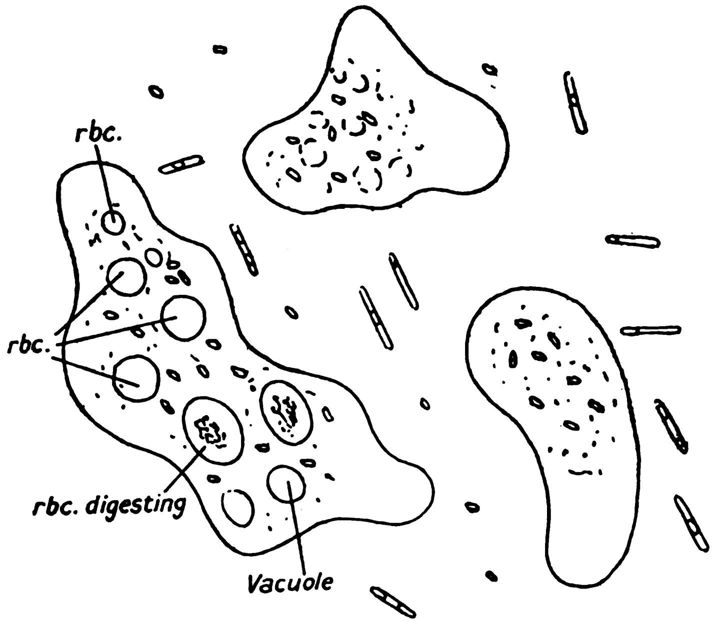
During the early months of the year these peculiar structures, with their strongly iodophilic bodies, were frequently met with in the stool. They were present sometimes in very large numbers and it is interesting to note that the most intense infections were

met with amongst a series of native prisoners we examined in Hadra prison. They were present in 14·8 per cent of the prisoners.

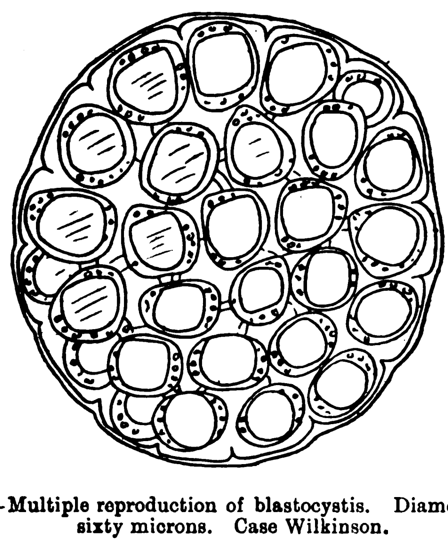
Examination of the daily ration microscopically did not reveal any source of infection.

The I. cysts are generally easily recognized if one employs iodine. Sometimes without this it is impossible to identify them certainly, as the iodophilic body may be mistaken for the chromidial body of a cyst of *E. histolytica*. The iodophilic body however tends to be rounded or lobed, while chromidial bodies in the *E. histolytica* cysts are generally rod like. The I. cysts vary greatly in size and shape. They may be quite small with a diameter of 7 or 8 microns, or large with a diameter of 15 microns or more. Though most usually they tend to be circular or oval in outline they may be lobed or show processes which suggest an outgrowth into a filament. The single nucleus is smaller than the nucleus in the single-nuclear *E. histolytica* cyst, and furthermore it is different in appearance and structure. In one or two cases we have come across fairly large infections of cystic structures which resemble the I. cysts in every way except for the absence of the iodophilic body. These caused us a good deal of difficulty as there was a decided resemblance to *E. histolytica* cysts. After careful observation of the cases it was possible to make up one's mind that these were really I. cysts minus the iodophilic bodies. In typical I. cyst infections, where the majority of the cysts have the characteristic iodophilic bodies, a few may be seen in which these are absent (Plate III, fig. 15).

In one or two cases there have occurred in the stool large spherical cysts which look very much like cysts of *E. coli* with a single nucleus. In stained films or iodine preparation each is seen to have a single nucleus, which is a spherical body with a very thick nuclear membrane, while the central part is clear and unoccupied by granules or other structures. It has the appearance of a homogeneous body with a central vacuole. When first seen it was thought the cysts were peculiar forms of the cysts of *E. coli*, but by following the cases for a few days it was found there was no tendency for recognizable stages of *E. coli* cysts to appear. It was evident that they were not amœbic cysts. It seems most probable that they represent large I. cysts which are devoid of iodophilic bodies or structures of an allied nature. One such case as this was seen by one of us during the routine examination in London of patients returning from Gallipoli at the end of 1915.



Text Fig. 4.—A drawing of part of the field of the microscope showing *E. histolytica* containing spores of a spore-bearing bacillus (*B. megatherium?*) which was plentiful in the stool. One of the amœbæ contains several red blood corpuscles. Case Smith, July 14, 1916.



Text Fig. 4.—Multiple reproduction of blastocystis. Diameter of large cyst sixty microns. Case Wilkinson.

(19) *Blastocystis.*

These organisms are of exceedingly common occurrence, at least a quarter of the stools examined containing them. In certain cases they are present in very large numbers and the largest infections we have seen have been associated with an acute diarrhœa. Under these conditions one often notes abundance of very large forms quite as large and even larger than cysts of *E. coli.* On the other hand there may be an overwhelming infection of very small forms. Whether large or small, it will be noted that under these conditions the blastocystis are mostly in various stages of division, suggesting that active multiplication is taking place.

Often the blastocystis occur in large clusters, and on one occasion such a cluster was enclosed in a definite cyst, reminding one of the multiple division stages described by Alexeieff (text fig. 4).

In one instance a large blastocystis infection developed in a case which was being controlled for *E. coli.* It was noted that though blastocystis were present it was only in small numbers. At one period these increased in numbers and there suddenly developed an acute diarrhœa, the stool then containing enormous numbers of dividing blastocystis. After the attack was over the blastocystis were reduced to their original small number.

The fact detailed above would suggest a possible pathogenicity for blastocystis when present in any quantity, but one has to be cautious in coming to such a conclusion, for all other factors must first be eliminated. For instance, in certain cases of undoubted bacillary dysentery the blastocystis have been very numerous in the stool while, large infections may be met with in perfectly healthy individuals.

(20) *Waskia intestinalis.*

(Plate IV.)

The small flagellate for which we suggest the name *Waskia intestinalis* was found in two cases in Alexandria and there is some evidence that the second case became infected from the first while in hospital. The first case was one of a man who was admitted to hospital as a carrier of *E. histolytica.* The flagellate was first noted in the stool a week after his admission and was regularly present for one and half months. Towards the end of this period a tetramitus infection appeared, while the waskia infection became smaller and finally disappeared. The flagellate infection had withstood a course of injections of twelve grains of emetine early on in

the observation. The second case was that of a man who was admitted to hospital also as a carrier of *E. histolytica*. He was passing the small type of *E. histolytica* cysts. On his admission to hospital the cysts became reduced in numbers and finally vanished from the stool, which was being carefully searched daily. After a period of three weeks in hospital the patient suddenly developed a large waskia infection, and it is interesting to note that he was in the same ward as the first case and occupied the next bed but one. It seems probable that the second case contracted the infection from the first case, who was passing enormous numbers of the encysted forms of waskia in the stool. The second case still infected was discharged from hospital ten days after the infection was detected. There was no evidence that the flagellate was in any way pathogenic. The first case tended towards constipation, which had to be relieved by repeated doses of salts. The second case was also treated in this way while in hospital.

Description of the Living Flagellate.—The living flagellate (Plate IV, figs. 1 to 6) is a small active oval organism which dances about amongst the fæcal matter by means of its two flagella of different strength and action. The long, thin, anterior flagellum lashes about continuously and propels the flagellate through the liquid, while the stouter and shorter flagellum which projects from the cytostome may work either regularly, but at a different rate from the anterior one, or irregularly with periods of rest alternating with periods of activity. This independent action of the stout cytostome flagellum, especially when its action is intermittent, gives a peculiar jerky movement to the anterior end of the flagellate as it swims forward under the regular action of the long anterior flagellum. In cover-glass preparations the flagellate has a peculiar habit of applying itself to the surface of the cover-glass or slide to which it adheres. In this position the action of the two flagella can be easily studied, and it is in this side view attitude that the flagellate reminds one so forcibly of the body outline of a bird.

In shape the flagellate is ovoid with the anterior end rounded and the posterior end pointed. There is a cytostome at the side of the anterior end, while the tapering part of the posterior end tends to be on the side of the body opposite to that on which the cytostome opens. This arrangement makes the flagellate bilaterally symmetrical. From the anterior end, but slightly nearer the cytostome side of the body, there takes origin a thin flagellum which equals the body in length. A second stouter and shorter flagellum arises from the inner part of the anterior wall of the

cytostome. It passes slightly backwards and outwards through the mouth of the cytostome, from which it projects for a considerable distance. The separate action of the two flagella has been explained above. The cytoplasm of the flagellate body is very pale, much paler and less refractile than that of small forms of tetramitus or trichomonas. It is frequently much vacuolated and the vacuoles contain bacilli or cocci which have been ingested. One can often see quite large bacilli entering the cytostome. The nucleus occupies the anterior end of the body and in the living flagellate can hardly be detected except as a clear, more homogeneous area which is devoid of the granulations or vacuoles of the rest of the body. The length of the body varies from 4 to 9 microns, the majority of flagellates being 5 to 6 microns long. The width varies considerably; the narrow forms three to four microns in width mostly resemble a bird in outline; wider forms occur in which this resemblance is lost, and finally forms which are practically spherical are found. In addition to these forms there occur others which are possessed of two cytostomes and two pairs of flagella. These might be either dividing or conjugating forms, but the examination of stained specimens shows the former view to be correct.

Encysted forms of the flagellate are common in the stool (Plate IV, figs. 7 and 8). These are pear-shaped bodies 4·5 to 6 microns in length. They have a pearly-white appearance and are quite structureless. They remind one of small tetramitus cysts, but have not the few refractile granules which these cysts generally possess. That these bodies are actually cysts of the flagellates is proved by their constant association with it in the two cases mentioned and their complete absence from all other cases observed by us.

In the two cases of *W. intestinalis* infection the flagellates were present in the stool in enormous numbers during the height of their development; many flagellates were present in each field of the $\frac{1}{12}$ objective. In the first case, from the stool of which they disappeared after about six weeks' observation, the flagellates became reduced in number towards the end and appeared as if they were being crowded out by the larger and more vigorous tetramitus. Knowing, however, that flagellate infections are peculiarly irregular in their course, we recognize that it is possible that the infection had only been reduced temporarily.

Description of Stained Flagellates.—The flagellates were studied in films fixed in Schaudinn's fluid and stained by the iron hæmatoxylin method, and also in dry films stained by Romanowsky

stain. In the stained film the flagellate is seen to have the same shape as that of the living organism. The nucleus at the anterior end can be more clearly seen, and is found to consist of a spherical nuclear membrane with usually a central karyosome. On the surface of the nuclear membrane towards the cytostome are two granules from which arise the two flagella. The dividing forms are seen to have a simple dividing nucleus in which a centrodesmose can be detected and at a later stage two distinct nuclei (Plate IV, figs. 9 to 14).

The encysted forms show more details when stained than in the living condition. Certain nuclear structures can be made out within the cyst, though the exact significance of the appearances are doubtful. The nuclear membrane becomes much elongated and may stretch from one end of the cyst to the other, while the karyosome tends to become dumb-bell-shaped and divided into several parts. Whether this is an indication of nuclear multiplication cannot be stated at present (Plate IV, figs. 15 to 20).

The flagellate which has just been described from two cases has never been encountered before, and is evidently a new parasite of the human intestine, and for this reason we have given it the name *Waskia intestinalis*, after the Orwa-el-Waska section of the 19th General Hospital where it was first discovered.

(21) *Tricercomonas intestinalis*, n.g., n.sp.

(Plate III, figs. 1 to 11.)

The small flagellate which we have found in about a dozen cases differs entirely from *Waskia intestinalis* already described. It is a small active organism which is very difficult to study on account of its rapid dancing movements. It has a spherical or ovoid body which is distinctly flattened on one side as in flagellates of the genus *Cercomonas.* The posterior end is drawn out and terminates in a flagellum which can be traced forwards along the flattened side to the anterior end of the body where three other long flagella originate. The tail flagellum appears to be attached to the surface of the body, and occupies this position in all the active movements of the organism. For this reason it seems clear that the flagellum is actually attached to the surface of the body and not merely applied to it as Woodcock thinks is the case in cercomonas, where the tail flagellum is similarly arranged. In the tricercomonas as well as cercomonas the cytoplasm of the body is drawn out into a tapering process which follows the flagellum for some dis-

tance, and it seems difficult to understand how this can be if the flagellum is merely applied to the body and not definitely attached. The posterior flagellum of tricercomonas and cercomonas is attached to the surface of the body as much as the flagellum of trichomonas is attached to the border of the undulating membrane, and in both flagellates this attachment may be broken down and the flagellum become free except at its point of origin. Tricercomonas, as the figures show, has three long anterior flagella and one posterior flagellum passing over the flattened side of the body, which moreover is sometimes grooved along its course. The flagellate resembles cercomonas, except that it possesses three instead of one anterior flagellum. Hence the name tricercomonas which we suggest. In the fresh condition the flagellate is very active, but some time after leaving the intestines the movements are less violent and the details can be studied. No definite cytostome could be distinguished, though bacilli and cocci are ingested. The body changes its shape very readily, and is to a certain extent amœboid. The body of the flagellate measures four to eight microns in length. The flagella are longer than the body. Sometimes the body of the flagellate is deformed, in that one or two curious pseudopodia or pedunculated processes project from the surface.

In one case the flagellate which was present in large numbers was associated with a small oval cyst six to eight microns long by about half this in breadth. No structure could be seen in the unstained specimens, but in stained films the cysts were found to contain one, two, or four nuclei of a type resembling the nuclei of the stained flagellates. It seems very probable that they represent the encysted stage of the flagellate (Plate III, figs. 5 to 8). In stained films the flagellate is found to have a nucleus like that of cercomonas, with a central karyosome and a nuclear membrane which is drawn out at one spot into a cone-like elevation, from the summit of which the flagella take origin. In stained films forms with two nuclei, probably dividing forms, can be found. As mentioned above the flagellate has been seen in about a dozen cases. Unlike *W. intestinalis*, which persisted in the stool for long periods, the *Tricercomonas intestinalis* was present only for a day or two at a time. In one case only was it present for as long as nine days, when it disappeared not to be found again. The cases were under observation in hospital and the stools were examined every day. There is no evidence whatever to suggest that the flagellate is in any way pathogenic. On account of its resemblance to cercomonas and its possession of three anterior flagella we suggest the name *Triceromonas intestinalis*.

(22) *Entamœba nana*, n.sp.

(Plate I, figs. 10 to 23).

The small amœba which, on account of its small size, we describe under the above name has turned out to be one of the commonest protozoa in the human intestine in Egypt, rivalling in some groups examined even *E. coli* in its frequency. The cysts of *E. nana* were seen by one of us in cases in London during the latter part of 1915, but they were thought to be of a vegetable nature, or possibly a stage in the encystment of tetramitus. One of the four-nuclear cysts was figured in a paper on the "Human Intestinal Protozoa" (*Lancet*, November 27, 1915, and JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, December, 1915, fig. 17) as a possible later stage of development of the cyst of tetramitus, which was also present. The small free amœbæ were also met with on several occasions but were regarded as *Amœba limax*, though a failure to obtain a culture on agar media on which *A. limax* was growing threw some doubt on this. In Egypt, however, we have had ample opportunity of studying this amœba in cases which have been under daily observation in hospital and we have been able to definitely associate the small oval or spherical cysts with the small amœba. The type of infection with *E. nana* resembles that of other intestinal protozoa. The amœbæ or their cysts may be passed continuously over comparatively long periods, or the infection may be apparent for only a few days and then vanish only to reappear again after an interval. *E. nana* occurred in a good number of the cases which were being controlled in hospital for *E. histolytica* infections (see Tables of Cases).

Very striking are the cases where cysts only in large numbers are passed daily in a constipated stool. The administration of a saline purge to such cases produces enormous numbers of minute amœbæ. In the soft unformed stool it is usual to find the free amœbæ and the cysts associated.

One must be careful to distinguish the cysts of *E. nana* from the cysts of the smaller strains of *E. histolytica*. The resemblance may be very striking and at times it may be necessary to stain films in order to arrive at a diagnosis. The small *E. histolytica* cysts are generally spherical or nearly so, while the cysts of *E. nana* are typically oval, very much like small lamblia cysts, though internally no structure can be detected. Spherical and irregularly shaped cysts of *E. nana* also occur, but these are always associated with the more typical oval forms. The cysts are never bottle-

shaped like the cysts of tetramitus, with which confusion might take place.

Free Amœbæ.—The free-living amœbæ are very small and have a diameter of 5 to 10 microns. Their structure varies considerably. They may be very vacuolated and contain bacteria and cocci or they may appear quite homogeneous (Plate I, figs. 10 and 11). The latter are possibly encysting forms which will give rise to the cysts which appear almost structureless when seen in the fresh condition. As a rule the amœbæ move sluggishly, throwing out one or more blunt ectoplasmic pseudopodia. They do not glide along in the true "limax" manner. The nucleus with its large chromatin block can sometimes, though rarely, be detected in the living amœbæ. The stained amœbæ (Plate I, figs. 12 to 17) show the same clear or vacuolated cytoplasm seen in life. The structure of the nucleus can however be more clearly seen. Generally this appears to be of the "karyosome" type with a clear nuclear membrane and large centrally arranged chromatin block or karyosome which is often irregularly shaped. The position of the chromatin block at the centre of the nucleus is often only apparent, for in certain positions of the nucleus it is seen to be lying laterally against the nuclear membrane. In those cases in which it seems to be centrally situated the appearance may be due to the nucleus lying with the chromatin mass on the upper or lower surface of the nuclear membrane as the amœbæ lies on the slide. Sometimes the laterally placed chromatin mass is connected with a filament which passes across the nucleus to a granule lying on the nuclear membrane opposite to it (Plate I, fig. 15). The occurrence of this type of nucleus in the amœbæ is of importance, for it is a very common type of nucleus of the encysted forms and greatly strengthens the belief that the cysts and the amœbæ are one.

Encysted Amœbæ.—The cysts of *E. nana* are oval, spherical or more irregularly shaped structures having a diameter of 7 to 8 microns when spherical and a length of 8 to 10 microns when elongated (Plate I, figs. 18 to 23). The later type is most easily recognized as a pale whitish and structureless body in which no detail can be detected. Even when mounted in iodine it is only occasionally that the internal nuclei can be seen. The cysts of the amœbæ have hitherto been regarded as of a vegetable nature. Fixed in Schaudinn's fluid and stained with iron hæmatoxylin the nuclear details can be as clearly seen as the small size of the cysts permit. There are either one, two or four nuclei, and these are generally grouped together towards one end of the cyst. Most important is the

structure of the nucleus. It will be seen by reference to the figures in Plate I that the chromatin is generally arranged as a mass at one side of the nuclear membrane, while very frequently a fine filament connects the mass with a granule on the opposite side of the membrane. The occurrence of this type of nucleus both in the free amœbæ and the cysts dispels all doubt as to the identity of the two.

As already stated, the *E. nana* is of very frequent occurrence, and has been constantly encountered in the course of routine examination now that we have learned to identify it. The amœba has undoubtedly been seen before, but has been confused with small forms of *E. coli* or *E. histolytica*, with which it is often found. It has only been by careful study of a number of cases, and above all of cases from which the other entamœbæ were absent, that we were able to exclude any connexion with them. The course of the infection was very strikingly followed in two cases which had been cured of *E. histolytica* infections. The greatest amount of confusion has probably existed between this amœba and *Amœba limax*, or the amœba which is generally known by this name. *A. limax* can be cultivated from the human stool, but all our attempts to obtain culture of *E. nana* have failed. One stool which was much delayed in reaching us contained numerous minute amœbæ and small spherical cysts like the cysts of the amœbæ which readily grow on agar and which are quite unlike the cysts of *E. nana*. This material planted on agar plates gave rise to a good culture of amœbæ, and the spherical cysts were there reproduced. Material containing *E. nana* was inoculated on the same medium on the same day from two cases, but no growth was obtained. It seems clear, therefore, that *E. nana*, like *E. coli* and *E. histolytica*, will not grow on agar, which is suitable for the growth of *A. limax* or similar forms. The amœba which we have designated *E. nana* corresponds with none of the amœboid organisms which have been described from the human intestine. The *E. butschlii* of Prowazek, a much larger form, resembles it most. This author's description, however, is too meagre to allow of any comparison being made. Moreover, he does not describe any encysted forms.

As regards the nomenclature of this amœba we have placed it with the entamœbæ because it appears to be truly parasitic. In nuclear structure, however, there are certain differences, though, as with the entamœbæ, the chromatin material is mostly arranged on the nuclear membrane. Aggregations of chromatin are not uncommon in the nuclei of *E. histolytica*. Furthermore, it is very

doubtful if nuclear structure alone can be regarded as a distinguishing feature of the genus Entamœba. It seems safer, therefore, to include this form with the truly parasitic amœba under the name *Entamœba nana* than to class it with the free-living non-parasitic amœba.

Summary of Matter discussed in Part II.

(1) It is often quite impossible to distinguish unencysted forms of *E. histolytica* from *E. coli.* The cysts, however, can be distinguished. Accordingly, it is safer to diagnose *E. histolytica* only if the amœbæ contain red blood corpuscles or if definite four-nuclear cysts are present. Some rules to act as a guide to the diagnosis of intestinal amœbæ are given.

(2) The cysts of *E. histolytica* vary greatly in size. There occur certain strains of *E. histolytica* with cysts 7 to 10 microns in diameter, strains with cysts of intermediate size and finally large strains with cysts 15 to 19 microns in diameter.

(3) There is no doubt that the presence of the four-nuclear cyst is an indication of infection with *E. histolytica*, even when there has been no history of previous dysentery. The cysts from carriers who have never suffered from dysentery may give rise to acute amœbic dysentery in kittens.

(4) Cases may remain infected with *E. histolytica* for years. There are in these cases periods of acute dysentery, when amœbæ with included red cells are present in the stool, alternating with periods of comparative health when only small amœbæ and cysts are passed. Cases may remain as healthy carriers for long periods without showing any signs of dysentery. It is probable that these healthy carriers really have some ulceration of the large intestine, which however is not so extensive as that in the acute dysenteric.

E. histolytica may establish itself in the gut with the production of true dysentery or without the production of any symptoms whatever. In the removal of new troops from England to areas in which amœbic dysentery is not endemic it is inadvisable to station them, even for a short time, in centres of amœbic dysentery like Egypt unless urgent military requirements leave no other alternative.

(5) The bacillary dysentery stool when seen at the height of infection is characteristic, both macroscopically and microscopically, and can be recognized by its general appearance and by the extraordinary cellular exudate when viewed under the microscope. The

amœbic dysentery stool contains darker blood and mucus but cannot be recognized with certainty apart from the amœbæ. There is absence of the cellular exudate of the bacillary dysentery mucus.

(6) The characters of the unencysted *E. coli* are so indefinite as to render its identification, apart from the cysts, most difficult. We have obtained no evidence that *E. coli* can ingest red cells. The cysts of *E. coli* vary in size from thirteen to well over thirty microns. These cysts may contain chromidial bodies.

E. coli is not always to be found in the stools of persons who are known to be infected. There is no evidence that *E. coli* is even pathogenic.

(7) *Lamblia intestinalis* reproduces by a process of longitudinal division in the unencysted state. The flagellate may vary very much in size. Judging by the presence or absence of encysted or free forms of lamblia in the stool, the infection runs a very irregular course. The flagellates may be absent from the stool for comparatively long periods. Of all the flagellates of the human intestine lamblia has the greatest claim to pathogenicity.

(8) *Tetramitus mesnili* occurs in the stool in the free and encysted stages and one or both of these may be present at one time. Tetramitus infections, like those of lamblia, run a very irregular course.

(9) The commonest form of human trichomonas in Egypt is that with four anterior flagella (tetratrichomonas). The three (trichomonas) and five (pentatrichomonas) flagellar forms also occur. An axostyle is always present. A trichomonas of the mouth in pyorrhœa occurs and appears to be distinct from the intestinal form. Trichomonas infections may persist for long periods, during which the flagellates cannot always be detected in the stool. There is little evidence of the pathogenicity of trichomonas.

(10) A case of coccidium (isospora) infection was followed for some time. Emetine appeared to cure the infection.

(11) Iodine cysts (I. cysts) were commonly found and their likeness to cysts of *E. histolytica* was sometimes very close.

(12) Blastocystis infections were very common and the largest infections and the largest forms were found in cases of diarrhœa or dysentery.

(13) Two new human intestinal flagellates (*Waskia intestinalis* and *Tricercomonas intestinalis*) and a new amœba (*Entamœba nana*) are described.

PLATE II.

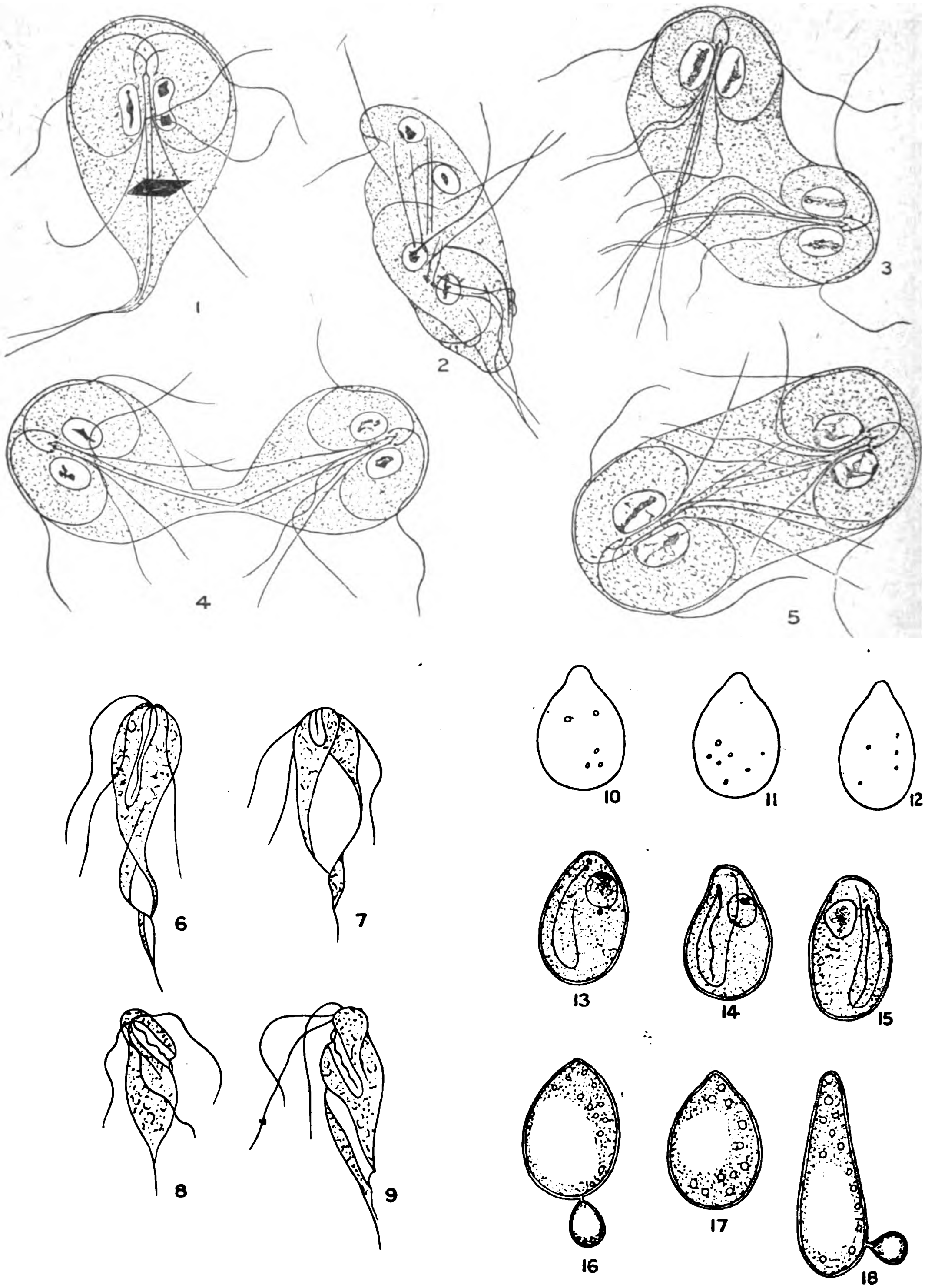
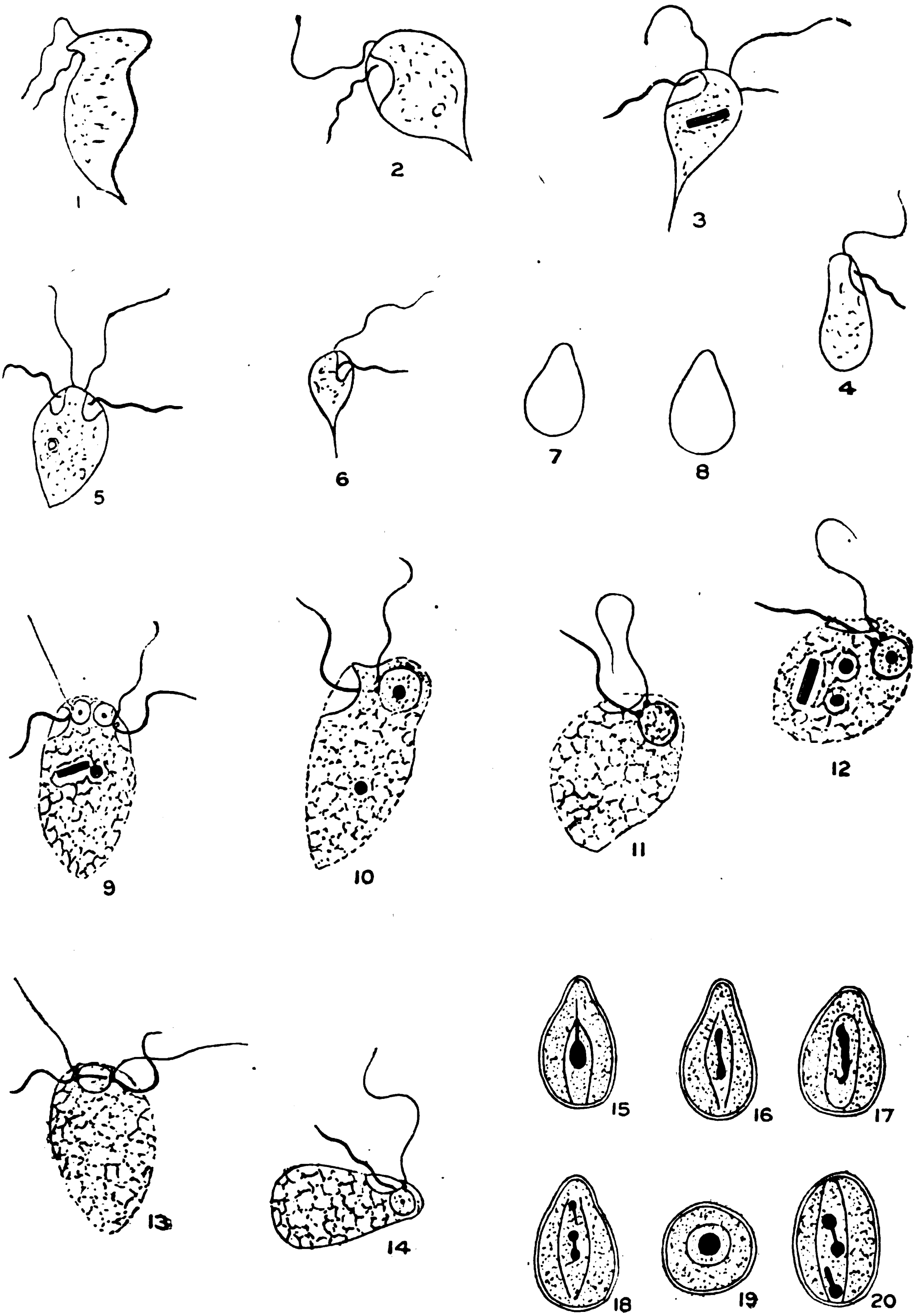


PLATE IV.



DESCRIPTION OF PLATES.

PLATE I.

FIGS. 1 to 9.—Cysts of *Entamœba histolytica* from three cases to show how distinct strains occur.

1 to 3: Cysts from case Healy, with a strain of *E. histolytica* producing large cysts. 4 to 6: Cysts from case Flynn, with cysts of intermediate sizes 7 to 9: Cysts from case Russell with cysts of small size. The cysts are drawn to the scale below fig. 9.

FIGS. 10 to 23.—*Entamœba nana*, n. sp.

10 and 11: Free forms are seen in fresh preparations. 12 to 17: Free forms are seen in films fixed in Schaudinn's fluid and stained with iron hæmatoxylin. Fig. 15 shows a type of nucleus which is often seen in the encysted forms. 18 to 23: Various stages in the development of the cyst. Forms with one, two, and four nuclei. Fig. 20 shows dividing nuclei. Fig. 22 shows a very characteristic type of nucleus, in which a large chromatin mass on one side of the nuclear membrane is connected by a filament to a small granule on the membrane opposite to it. The free amœbæ measure 5 to 10 microns in diameter, while the cysts are 8 to 10 microns in length.

PLATE II.

FIGS. 1 to 5.—Various stages in the longitudinal division of *Lamblia intestinalis*.

1: Division of nuclei. 2: Form with four nuclei. 3: Commencing division of body. 4: Final stage of division. 5: Form with two sucking disks developed.

FIGS. 6 to 15: *Tetramitus mesnili*.

6 to 9: Forms showing twisting of the body, a condition very commonly seen. 10 to 12: Encysted forms as seen in fresh preparations. The only contents to be seen are a few refractile granules. 13 to 15: Encysted forms stained with iron hæmatoxylin. The nucleus, cytostome with its flagellum and some granules are clearly brought out.

FIGS. 16 to 18.—A yeast which in shape and size closely simulates the cysts of tetramitus.

PLATE III.

FIGS. 1 to 11.—*Tricercomonas intestinalis*, n. g., n. sp.

1 to 4: Flagellate as seen in the living condition with three anterior flagella and flattened side along which runs the fourth flagellum to become free at the posterior extremity. 5 to 8: Cysts which are probably those of the flagellate with which they were associated. 9 to 11: Flagellates as seen in stained films. The flagellates are 4 to 8 microns in diameter; the cysts 6 to 8 microns in length.

FIGS. 12 to 17.—Iodine cysts as seen in stained films. The iodophilic body appears as a vacuole. Often there is a difficulty in distinguishing cysts of *E. histolytica*. The nucleus however is smaller than that of the *E. histolytica* cyst with single nucleus. Fig. 15: I. cyst without vacuoles. The cysts shown in the figures measure seven to ten microns in longest diameter.

FIGS. 18 to 23.—*Trichomonas intestinalis*.

18: Pentatrichomonas form. 19 to 23: Tetratrichomonas forms. 18 to 20 are from osmic vapour preparations, stained by eosin azur. 21 to 23 are from sublimate wet fixed films stained by iron hæmatoxylin.

PLATE IV.

FIGS. 1 to 20.—*Waskia intestinalis*, n. g., n. sp.

1 to 8: Flagellates as seen in fresh preparations; 1: form with characteristic bird-like appearance; 2, 4, 6 forms showing cytostome with the thick flagellum projecting from the cytostome and the single thin anterior flagellum. 3 and 5: Dividing forms. 7 and 8: Structureless cysts of flagellate as seen in living condition. 9 to 14: Flagellates as seen in films fixed in sublimate and stained by iron hæmatoxylin. 9 and 13: Dividing forms. 10, 11, 12, 14: Ordinary type of flagellate. 15 to 20: Encysted forms as seen in films fixed in sublimate and stained by iron hæmatoxylin. Some of the cysts show nuclear changes, which may be indications of nuclear divisions. 19: End view of cyst.

ON THE NITROGENOUS FOOD REQUIREMENT OF SOME OF THE COMMONER PATHOGENIC BACTERIA.

By Lieutenant-Colonel M. H. GORDON, M.D.
Royal Army Medical Service.

The primary motive of the present investigation, which was carried out antecedent to the War in connexion with a grant from the Local Government Board for the purpose, was to ascertain whether the commoner pathogenic bacteria exhibit any marked difference in regard to their individual capacity to break down certain nitrogenous substances of known chemical composition. Should such difference be found to obtain, it was anticipated that the divergency might have a practical application for the purpose of differentiating these bacteria: variation in katabolic activity for nitrogenous compounds thus finding application in a similar manner, that variation in regard to katabolic activity of these bacteria for certain carbohydrates is now exploited.

As a start, cultures of thirty of the commoner bacteria met with in disease-processes were compared with regard to their action on materials such as serum, whey, and a dilution of egg albumen. The results, however, were not encouraging for the object then in view. The second step, therefore, was to start at the other end of the scale and to ascertain the action of these bacteria on some of the simpler nitrogen-containing substances which occur during the degradation of albumen. Beginning with ammonium salts, trial was made in turn of a nitrite, nitrate, amine, amide, and of amino acids. These substances were added severally to a solution of yeast ash in water, and the tests were conducted in duplicate with and without the addition of glucose respectively. In the course of these experiments it was found that there was difficulty in some cases in deciding whether growth had taken place or not in the fluid media. This led to the next development, which it is the principal purpose of the present paper to describe.

The question as to whether the bacteria were multiplying or not in the fluid media drew my attention to the fact that before investigation of katabolic activity on the part of these bacteria could be undertaken with profit, it was first of all advisable to ascertain whether the bacteria in question were capable of utilizing such nitrogenous substances as food or not. In short, the anabolic action of the nitrogen-containing substances on the bacteria demanded investigation even more urgently than the

katabolic action of these bacteria on the nitrogen-containing substances: for the fact of growth or no growth on a medium of known chemical composition promised to afford as practical a means of differentiation as well could be desired.

The procedure employed for determining whether one or another nitrogen-containing substance was suitable for the vital synthesis of the bacteria in question was as follows. The bacteria selected for trial were:—

(1) *B. coli.*
(2) *B. typhosus.*
(3) *B. paratyphosus* B.
(4) *B. dysenteriæ* (Flexner).
(5) *B. pyocaneus.*
(6) Friedlander's bacillus.
(7) *B. proteus.*
(8) *V. choleræ.*
(9) *B. diphtheriæ.*
(10) *B. pseudodiphtheriæ* (Hoffmann).
(11) *Staphylococcus epidermidis.*
(12) *S. pyogenes.*
(13) *Streptococcus pyogenes.*
(14) *S. fæcalis.*

The menstruum on which all the experiments were conducted was prepared as follows:—

A quantity of fibre agar was obtained and well washed by soaking it for forty-eight hours in several changes of distilled water, after which it was dried. Three per cent of this agar fibre was then dissolved by heat in a solution of the "necessary salts" which Fischer found essential for bacterial growth.

The formula for these is as follows:—

K_2HPO_4	0·1 per cent.
$MgSO_4$	0·2 ,,
$CaCl_2$	0·01 ,,
NaCl	0·5 ,,

The solution of agar and necessary salts obtained in this way was then divided into three portions. The first was used for control experiments, the second received the addition of the nitrogenous substance of test, the third received the same and also one per cent of glucose. The way in which the nitrogenous substance of test was added was as follows:—

Nine cubic centimetre amounts of the agar with and without addition of glucose respectively were filled into test tubes and sterilized. When a given nitrogenous substance was submitted

to trial some of these tubes were melted, and then one cubic centimetre of a sterilized 10 per cent solution of the substance of test was run into each tube. The proportion of nitrogenous substance in the medium was thus approximately one per cent except in the case of substances such as asparagin, only sparingly soluble in water; in these a cubic centimetre of the saturated solution was run into each tube. After thorough admixture of their contents, the tubes were sloped in the usual way, and allowed to set. For the purpose of distinguishing the three media, the tubes of each were plugged with a different coloured wool.

The nitrogenous substances selected for trial were as follows:—ammonium chloride, ammonium phosphate, ammonium carbonate, ammonium carbamate, potassium nitrite, potassium nitrate, ethylamine, acetamide, carbamide (urea), asparagin, aspartic acid, alanin, glycocoll, peptone (Witte).

The tubes containing these substances were inoculated with pure cultures of the various micro-organisms, and then incubated for forty-eight hours at 37° C. The results are shown in the following tables:—

TABLE I.

COMPARISON OF B. COLI WITH B. TYPHOSUS.

MICRO-ORGANISM	*B. coli*		*B. typhosus*	
Medium	Alone	With glucose	Alone	With glucose
Control agar	−	−	−	−
Ammonium chloride	−	+	−	−
,, phosphate	−	+	−	−
,, carbonate	−	+	−	−
,, carbamate	−	−	−	−
Potassium nitrite	−	(+)	−	−
,, nitrate	−	(+)	−	−
Ethylamine	−	−	−	−
Acetamide	−	(+)	−	−
Carbamide	−	+	−	−
Asparagin..	(+)	+	−	−
Aspartic acid	(+)	+	−	−
Alanin	+	+	−	−
Glycocoll	−	+	−	−
Peptone (Witte)	+	+	+	+

+ = Good growth. (+) = Partial growth. − = No growth.

It will be observed that a fundamental difference obtains between *Bacillus coli* and *B. typhosus* with regard to their nitrogenous food requirement. Not only is the former micro-organism able to assimilate eleven of the nitrogenous substances which are useless to the typhoid bacillus under the conditions examined, but the

B. coli can synthesize its protoplasm from any of the three ammonium salts tested, provided that glucose is also present as a source of carbon. Herein undoubtedly lies the explanation of the relative hardiness of the former micro-organism outside the body as compared with the latter.

TABLE II.

COMPARISON OF B. PARATYPHOSUS B WITH FLEXNER'S DYSENTERY BACILLUS.

MICRO-ORGANISM	*B. paratyphosus* B (Wrexham)		*B. dysenteriæ* (Flexner)	
Medium	Alone	With glucose	Alone	With glucose
Ammonium chloride	–	(+)	–	–
Potassium nitrite	–	(+)	–	–
,, nitrate	–	–	–	–
Trimethylamine	–	–	–	–
Acetamide	–	–	–	–
Carbamide	–	+	–	+
Asparagin	+	+	–	+
Aspartic acid	–	–	–	–
Glycocoll	–	+	–	+
Alanin	+	+	–	–
Peptone	+	+	(+)	+

It will be seen that the paratyphoid bacillus in question could satisfy its nitrogen requirement with ammonium salt, nitrite, or alanin, whereas the dysentery bacillus could not make use of any of these substances under the same circumstances.

TABLE III.

COMPARISON OF FRIEDLANDER'S BACILLUS WITH B. PYOCYANEOUS.

MICRO-ORGANISM	*B. Friedlander*		*B. pyocyaneus*	
Medium	Alone	With glucose	Alone	With glucose
Control agar	–	–	–	–
Ammonium chloride	–	–	–	+ P.
,, phosphate	–	–	–	+ P.
,, carbonate	–	–	–	+ P.
,, carbamate	–	–	–	(+ P.)
Potassium nitrite	–	–	–	–
,, nitrate	–	–	–	+
Ethylamine	–	–	–	–
Acetamide	–	–	(+)	+ P.
Asparagin	–	–	(+)	+ P.
Aspartic acid	–	–	(+)	+ P.
Alanin	–	(+)	+ P.	+ P.
Glycocoll	–	–	(+)	+
Peptone (Witte)	+	+	(+)	+ P.

(P. in case of *B. pyocyaneus* indicates positive production of pigment.)

Here again a comparison of their relative capacity of vital synthesis under the conditions examined brings out a striking difference between *B. pyocyaneus* and Friedlander's bacillus, the former being able to satisfy its nitrogen requirement with either ammonium salt, nitrate, or some of the amides or amido acids, all of which were useless to Friedlander's bacillus in similar circumstances.

TABLE IV.

COMPARISON OF A SPECIMEN OF B. PROTEUS WITH THE VIBRIO OF ASIATIC CHOLERA.

MICRO-ORGANISM	*B. proteus*		*V. choleræ*	
Medium	Alone	With glucose	Alone	With glucose
Ammonium chloride	–	+	–	–
,, phosphate	–	+	–	–
,, carbonate	–	(+)	–	–
,, carbamate	–	–	–	–
Potassium nitrite	–	–	–	–
,, nitrate	–	(+)	–	(+)
Ethylamine	–	–	–	–
Acetamide	(+)	(+)	–	(+)
Carbamide	–	(+)	–	–
Asparagin	–	+	–	+
Aspartic acid	(+)	+	–	–
Alanin	+	+	–	–
Glycocoll	–	(+)	–	–
Peptone (Witte)	+	+	+	+

Whereas, when glucose is also present, *B. proteus* is able to satisfy its nitrogen requirement with an ammonium salt, the cholera vibrio does not possess this capacity. Similarly aspartic acid, alanin, and glycocoll can be synthesized by *B. proteus*, though not by the micro-organism of cholera.

Comparison was now made in the same way of *B. diphtheriæ* and *B. pseudodiphtheriæ* (Hoffmann), *Staphylococcus pyogenes* and *S. epidermidis*, *Streptococcus pyogenes* and *S. fæcalis*. It was found, however, that none of these six micro-organisms were able to make use of the nitrogenous substances in question below the rank of peptone.

SUMMARY.

Great differences obtain between some of the common pathogenic bacteria as regards their capacity of building up their protoplasm from various forms of nitrogenous food.

Whereas, when glucose is provided as a source of carbon, bacteria such as *B. coli*, *B. paratyphosus*, *B. pyocaneus*, and *B. proteus* can satisfy their nitrogen requirement either with ammonium salts or with sundry amides or amido acids, *B. typhosus*, Friedlander's bacillus, *B. diphtheriæ* and *B. pseudodiphtheriæ*, staphylococci, and streptococci appear to possess no such ability of synthesis from these simpler compounds of nitrogen.

The cholera vibrio and *B. dysenteriæ* (Flexner), while capable of building up their protoplasm from certain of the amido acids (e.g., asparagin), cannot make use in the same way of ammonium salts.

Clinical and other Notes.

THE INCUBATION PERIOD OF PARATYPHOID B FEVER

By Captain T. J. HALLINAN.
Royal Army Medical Corps.
AND
Captain H. E. ROAF.
Royal Army Medical Corps (Territorial Force).

The following case is of interest, as *Bacillus paratyphoid* B was found in the stools some time before the onset of the disease.

The patient, No. 403, Pte. McK., was admitted on September 23, 1915, suffering from "dysentery." A specimen of his stools was sent to the laboratory next morning (September 24, 1915); amœbæ were not found. On plating the stool dysentery bacilli were not found, but *B. paratyphoid* B was isolated. It was thought that the patient might be convalescing from paratyphoid B fever, so a serum reaction was carried out by the microscopic method, with negative results. Twelve days after admission (October 5, 1915) his temperature began to rise, so a blood culture was made on October 7, 1915, and *B. paratyphoid* B was isolated. On October 25, 1915, a serum reaction was again carried out, and agglutination of *B. paratyphoid* B was found in a dilution of 1 in 1,000 by the microscopic method. This case shows that *B. paratyphoid* B can be present in the intestine at least twelve days before the onset of the fever, and that cases which develop in hospital are not necessarily infected in hospital.

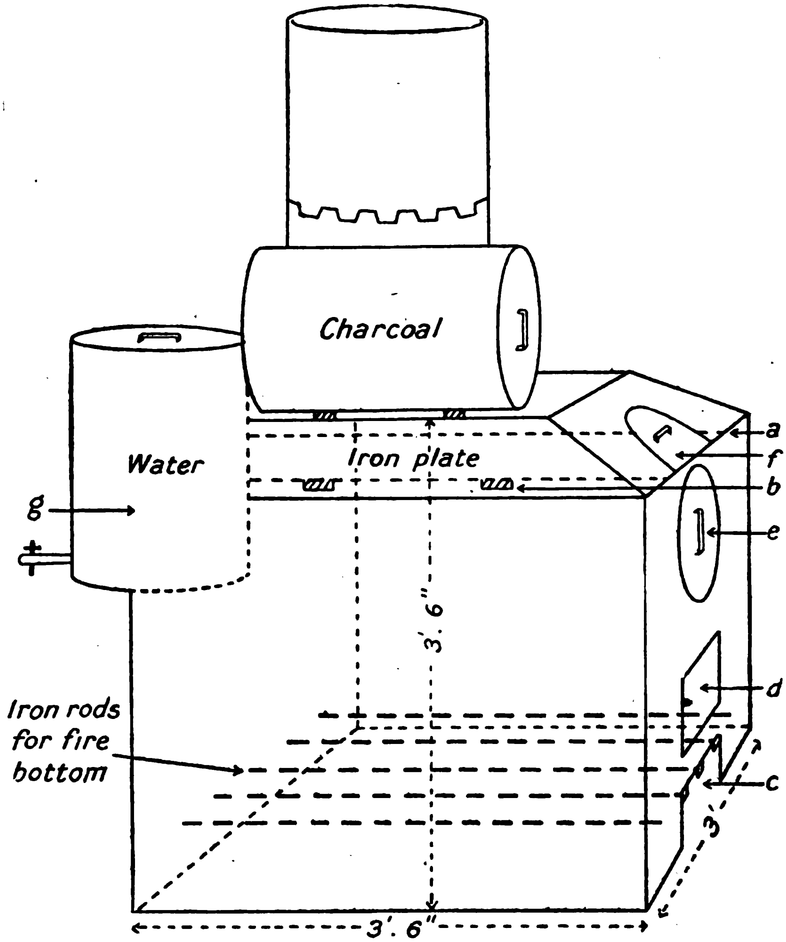
A SIMPLE FORM OF INCINERATOR.

By Lieutenant-Colonel J. MACKINNON.
Royal Army Medical Corps.

Incineration of excreta should be the aim of every military medical officer. For this to become a universal custom in the Army, simplicity of construction and efficiency of the incinerator are necessary. The incinerator depicted meets all requirements.

The main body is built of brick and mud. If bricks are unobtainable, rough stones will answer quite well. The front measures 3 feet across; back to front 3 feet 6 inches; and height to base of chimney, 3 feet 6 inches. The bottom of the fire consists of four or five iron rods. At level (a) an iron plate (rolled-out oil drum, or piece of corrugated iron), extends from front to back, leaving a space at either side, and is

supported by two iron rods (b) running crossways. The roof is also supported by iron rods. There is only one air inlet, at (c). An opening at (d), lined with a biscuit tin, is for raking the fire and removing tins; it also acts as an air inlet. The opening at (e) is lined with half an oil drum, with lid fitting loosely, and is for feeding dry camp refuse. The



inlet (f) is for excreta, which is emptied on to plate (a). The opening is covered by a plate of iron or tin. The excreta dries on the plate, and can be raked over either side on to the fire underneath, or allowed to char to nothing on the plate. The chimney is placed centrally, and consists of two oil drums.

This incinerator, with dimensions given, burns all refuse and dry excreta, for over 400 men, in about two hours, and would easily incinerate excreta for two battalions.

Incidentally, by building oil drums into the walls (g), a considerable quantity of hot water can be obtained, and this is much appreciated by the men for cleaning mess tins, &c. We have three such drums along the back wall of the incinerator, and there is no reason why this number should not be increased by placing others along the side walls. Also, by placing a couple of drums on the top, one on each side of the chimney, a considerable quantity of charcoal can be prepared. To do this, the lid of the drum must be removed, and when the drum has been packed with wood, the lid is refitted. Only a very small aperture must be left in the lid to allow of the escape of gasses, and exclude air. The charcoal is used for filtering and for braziers.

All the materials used in the construction of this incinerator are improvised. Once the iron rods have been procured, the chief difficulty has been overcome; and if these were made an issue for incinerator building, it would be a step in the right direction.

SIX CASES OF WOUNDS OF THE BUTTOCK WITH PERFORATION OF THE INTESTINE.

By Captain R. B. BLAIR.
Royal Army Medical Corps.

This short series illustrates the grave results which may accompany wounds inflicted by rifle or shrapnel bullets or pieces of shell in the region of the buttocks. I have learnt by personal experience that these wounds frequently penetrate the peritoneal cavity and cause injury to the viscera, and that they should therefore be subjected to the most careful investigation. During the last four months six cases of buttock wounds have been admitted into a ward under my charge at this Clearing Station. Some of these on first examination were thought to be slight, but subsequently proved to be of vital importance. If the wound is probed and the track does not appear to pass towards the peritoneal cavity, one may be led to infer that the abdominal viscera have escaped injury. The first of these reported cases shows that this test may be fallacious, and that further investigation is necessary. It is frequently far from easy to be certain that penetration of the abdominal cavity has occurred. The signs and symptoms of such a lesion may be self evident, or on the other hand, may be so anomalous as to give rise to great uncertainty. In those cases easy of diagnosis the general appearance of the patient is typical. The abdominal facies, pallor, sunken eyes and anxious expression, the legs drawn up, and respirations rapid and thoracic in type, present an unmistakable picture. The abdomen is rigid and tender;

vomiting is present and the pulse is rapid and irregular. Difficulties in diagnosis arise when such symptoms are slight in degree. The facial appearance may not assume an abdominal character, but generally a look of distress is present. Vomiting may be a delayed symptom, although nausea is often complained of. Abdominal pain may be slight and only elicited on pressure. Rigidity of the abdominal wall may be absent, and tenderness may be limited to one localized part. The character of the pulse is perhaps the most important sign; its rate is invariably increased, it becomes small in volume, thready and may be irregular.

The most important guides then are the pulse and facial appearance. As one famous consultant remarked on seeing one of these cases: "Yes, he looks more ill than a buttock case should." If the wound be probed, the track may or may not pass in the direction of the abdominal cavity. In all cases of doubt it is necessary to enlarge the wound and explore it thoroughly.

The first of these cases is a striking illustration of many of the points to which I wish to draw attention.

Case 1.—C. W., shell wound of left buttock.

History.—Wounded at 10 a.m. on April 18, arrived at —— at 10 p.m. same day, when he had cocoa to drink and vomited soon afterwards. He reached the Clearing Station at 1.30 a.m. on April 19. He walked into the ward, said he was slightly wounded, asked for some cocoa, and said he wanted to sleep. He slept well, had a breakfast of tea, bread and butter at 7.30 a.m.; was sick once at 9 a.m. At 1 p.m. he passed a small loose dark motion and said he felt much better. He complained of some abdominal pain which he referred to the concussion of the shell.

On examination the patient did not look seriously ill, he showed no pallor, but there was an expression of distress. The pulse was rapid—110 to 120—and small in volume. The abdomen moved well on respiration, and rigidity was not present. There was slight tenderness on palpation over the brim of the pelvis on the right side; percussion gave a resonant note.

The entrance wound one inch above the left tuber ischii had an inward and slightly upward direction towards the natal cleft. Vomited matter dark brown in colour, not stercoraceous, small in quantity.

When the patient was first seen by Colonel Rigby, consulting surgeon, he was standing upright, quite unconscious of his serious condition.

Operation at 4 *p.m., April* 19.—The buttock wound was laid open and the track was found to pass towards the coccyx, which was fractured. On this discovery it was decided to explore the abdomen. This was done by a median incision between the umbilicus and the pubes.

On opening the peritoneal cavity no free blood was found. There was evidence of peritonitis in widespread patches of lymph along the lower coils of the small bowel. The lowest portion of the ileum was

found adherent in the right iliac fossa, where free fluid like small bowel content was present. Free fluid was also present in the pelvis.

An oblique tear one inch in length was found in the wall of the bowel, about eighteen inches from the ileo-cæcal junction. Just inside the intestinal lesion there was a ragged piece of shrapnel about the size of the terminal phalanx of the thumb, within the lumen of the bowel. It was thought necessary to resect the damaged portion, and about two inches were removed. An end to end anastomosis was done with sutures of linen thread. The free fluid was mopped up with dry gauze; no other lesion was found.

A rubber drain was introduced into the pouch of Douglas, and the abdominal wall closed in layers with catgut. During the operation the patient had two pints saline given subcutaneously.

Recovery was uninterrupted. The drain was removed on the fourth day, and secondary sutures were introduced into the buttock wound on the fifth day. The bowels were moved on the fourth day. On the tenth day after the operation the patient was evacuated to the Base.

There are many points of interest in this case, but the most striking was the almost complete absence of symptoms indicating a severe abdominal injury. The patient was able to walk into the ward thirteen and a half hours after being wounded, and was able to stand up fifteen hours later. He had delayed vomiting, i.e., twelve hours after he received his wound, although he had had fluids to drink. The severity of the lesion was obscured by the absence of definite physical signs, the extraordinary good condition of the patient, and the misleading direction of the track of the missile.

The following are brief notes of the five remaining cases, to which slight reference has been made.

Case 2.—S. J., shell wound right buttock. Wounded 10 a.m., December 19, 1915; admitted 8 a.m., December 20. Entry wound situated two inches below and behind the anterior superior spine on the right side. No wound of exit. Vomiting took place on the evening of the 19th, and once again after admission. No complaint of abdominal pain, but tenderness in the right iliac fossa on palpation. Pulse rate 108.

Operation.—Laparotomy right rectus.

A small quantity of blood was present in the abdominal cavity. One perforation in the right wall of the cæcum was sutured with linen thread. Pelvic drain.

Result.—Died at 3 p.m. on December 21. Extensive gas gangrene was found in the wall of the cæcum and surrounding tissues.

Remarks.—The patient did not look like an abdominal case. The pulse rate was increased, and there was tenderness in the right iliac fossa, but it was only after exploration of the wound, that it was decided to open the abdomen.

Case 3.—Pte. G., shrapnel wounds of the buttocks. Wounded at

10 a.m., February 13, 1916. Admitted at 8 a.m., February 15, 1916. Entrance wounds, one in each buttock. No exit wounds. Patient in bad condition. Repeated vomiting of dark brown stercoraceous fluid. Pulse 130, thready.

Operation.—Median laparotomy. A small quantity of free blood was found in the peritoneal cavity. Two perforations were found in the upper part of the ileum with a tear in the mesentery. Four inches of gut were resected, and an end to end anastomosis was made. One perforation in the rectum was sutured. Pelvic drain.

Result.—Died four hours later.

Remarks.—The signs and symptoms of a severe abdominal lesion were obvious. The patient had to remain in a "dug-out" for forty-eight hours on account of shell fire before being brought to the hospital.

Case 4.—Schröder, Hans, gunshot wound left buttock. Wounded 4 a.m., March 27, 1916. Admitted 6 p.m., March 27, 1916. Entry wound ½ inch below the natal fold in the middle line of the posterior surface of the left thigh. No exit wound. Abdominal pain was felt one hour after the wound was received. He felt sick after admission, and vomited once before the operation. On palpation, tenderness was present in the left iliac fossa. Pulse 80, of good quality.

Operation 10 *p.m.*—Laparotomy, left rectus. The peritoneal cavity contained a considerable quantity of free blood. Two small perforations were found in an upper loop of the ileum, and were sutured with linen thread. No other lesions were found. The bullet was not found. Suprapubic drain inserted.

Result.—Good recovery.

Remarks.—The general condition and pulse were good. The history of abdominal pain after the wound was received, was definite. The wound of entrance was below the buttock, but when shot, the patient was in a stooping attitude.

Case 5.—Lance-Cpl. H., shrapnel wound of left buttock. Wounded 4 p.m., March 27, 1916. Admitted 6 a.m., March 28, 1916. Wound of entry in the left buttock. No exit wound. Abdominal pain and rigidity were present. Vomiting took place on the evening of March 27, and was repeated during the night. Pulse 120, feeble.

Operation.—A catheter passed produced bright blood. The wound in the buttock was explored, and found to have fractured the coccyx. Median laparotomy. Multiple wounds were found in the small gut, and a tear two inches in length was found in the superior wall of the bladder. A double resection of eighteen inches and four inches with end to end anastomosis was done, three other perforations were sutured, and the tear in the wall of the bladder was closed by suture. A fragment of shrapnel was found lying in a fold of mesentery. Pelvic drain.

Result.—Died on completion of the operation.

Remarks.—The condition of this case was desperate, he looked pinched and collapsed and the pulse was of very poor quality.

Case 6.—S. F. E., shell wound of left buttock. Wounded at 12 p.m. on April 6, 1916. Admitted at 6 a.m. on April 7, 1916. Wound of entry in the left buttock. No exit wound. Tenderness on palpation was present in the right iliac fossa and right lumbar region. The patient vomited twice after admission and during the night. Pulse-rate 120.

Operation.—Median laparotomy. A quantity of foul-smelling fluid was present in the peritoneal cavity, but no blood. Peritonitis was generalized. Two perforations were found in the ileum twelve inches from the ileo-cæcal junction—they were sutured with linen thread. No fragment of metal was found. Pelvic drainage.

Result.—A fæcal fistula developed on the fourth day after the operation. The patient was evacuated to the Base on the eleventh day after the operation. The discharge was then less, pulse was 96, temperature 99·8° F., and the general condition good.

Remarks.—The patient looked ill, the pulse was rapid, there was vomiting and the direction of the wound was towards the abdomen.

I wish to express my indebtedness to Lieutenant-Colonel Langstaff for his kind permission to publish these cases.

THE RECOVERY OF SOME WASTE PRODUCTS.

By Captain J. CARROLL.

Royal Army Medical Corps (Territorial Force).

There is little need at the present day to emphasize the extreme importance of economy, though it is needful to give a wider meaning to this term, especially in regard to what are termed "Waste Products," substances which have been systematically wasted and thought to be of practically no value. The importance of economy is generally recognized though the means of practising it may be somewhat defective. One strong argument can be advanced why these means should be improved, there is money in waste products. Now one of the most vital needs of the Empire is high explosives, and in order to increase our supply of glycerine for the making of these, it is essential to save every possible ounce of fat, grease and oil.

Waste Grease.

In making use in camp of that crude arrangement, the grease-trap, so called, one is directed to burn the grease—impregnated straw, grass, or other material in which the grease is more or less (usually less) entangled. Surely this is gross and unjustifiable waste of valuable material and ought to be stopped at once.

It is well known that in connexion with every mess large quantities of fatty substances are handled, and also that much grease, resulting, for example, from the washing of dishes and plates, is lost through defective means of treating the greasy water. The amount of grease so lost may be comparatively small in any one mess, while the bulk of water to be treated may be large. Nevertheless, one must not argue that this small amount of grease is not worth the trouble of recovering. It must be steadily borne in mind that this is only one of thousands of messes in our large army, and that the aggregate amount is enormous. A small amount of grease spread out thinly on the surface of a fairly large amount of water may be quite, or almost, impossible to recover.

Conditions of Success in Grease Recovery.

To ensure success in this process of grease recovery one must comply with certain easily defined conditions:—

(1) The water in which the dishes are dipped to remove the grease must be boiling, and kept so during the dipping process.

(2) The bulk of the water must be kept as small as possible.

(3) After the dipping is finished, the surface area of this water must be reduced to small dimensions so as to get the grease on a small area and increase its thickness.

(4) This being done, the grease must be caused to solidify quickly, by which means even large quantities of greasy water can be dealt with in a comparatively short time, and so economize time.

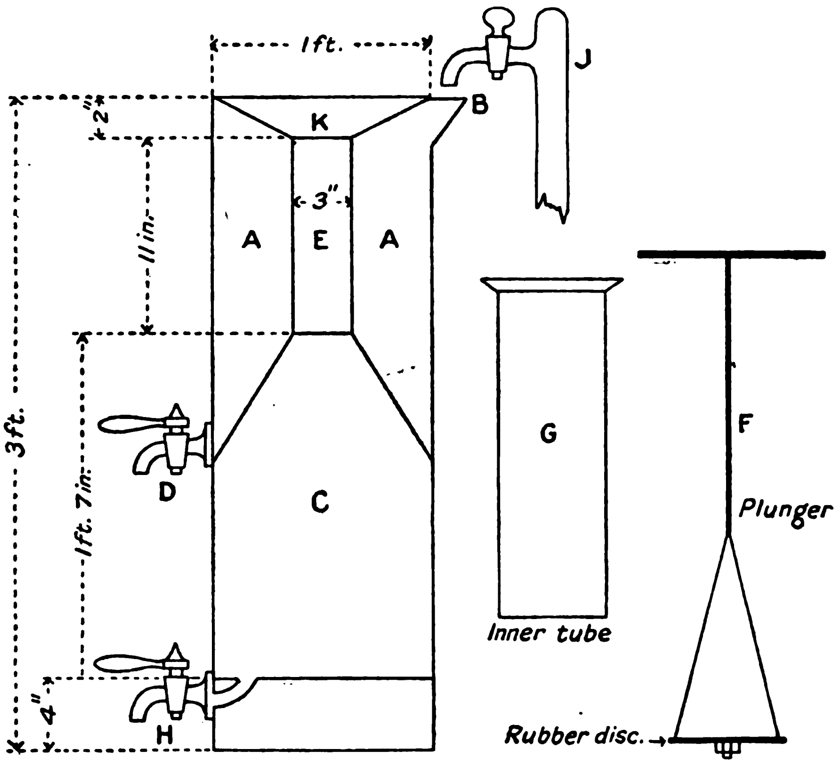
Grease Removal and Washing Distinct Operations.

I have spoken of the "Water into which the dishes are dipped." I do so for the reason that the removal of the grease from the plates and the washing of the plates are quite separate and distinct operations. The former—grease removal—should be done by dipping the plates into boiling water a sufficient length of time to dissolve all the grease; the latter—the washing—in cooler or even cold water, the grease having been removed by the dipping. The dipping water contains the grease, the washing water should contain none. The washing water can therefore be run direct into soakage pit or drain without risk of creating a nuisance.

Considering the value of this grease, and the crudeness of the present methods which do not make for success, an apparatus has been constructed which is simple, easily worked, and effects the grease recovery quickly. It is believed to be as nearly as possible "foolproof."

The details of the method of using the apparatus are given below, and if followed, must result in the recovery of this waste grease, a very large proportion of which is lost at the present time through defective methods.

This would prove of monetary value to each unit of our now very large Army, the money resulting from the sale of the grease going to swell the unit's funds.



INSTRUCTIONS FOR USE OF APPARATUS.

(1) The taps D and H are turned off. Insert G in E and F in G.

(2) Fill chamber C with the greasy water to be treated up to the top of the tube E, to the point marked K. Pour in the greasy water at K.

(3) Fill chamber A with cold water by turning on the tap J.

(4) As soon as chamber A is filled up to B with cold water turn off tap J.

(5) Immediately the grease which has risen to K has solidified, remove tube by grasping the cross handle of F and lifting. All the grease is taken out in tube G, and can be extracted from it by pulling F through it.

(6) Replace tube G and plunger F in E.

(7) Empty chamber C by turning tap H.

(8) If the water in chamber A should become hot, empty by turning tap D and refill by tap J. Cold water might be made circulate round tube E by means of a coiled pipe if preferred. The plunger F has a disc of rubber, exactly filling G, at its lower end. This rubber disc fits accurately tube E also.

CALCIUM STEARATE, OLEATE AND PALMITATE.

The same apparatus used to recover the waste grease can be used to recover the waste soap in washing water. This soap can be thrown out

of solution by the presence, accidental or intentional, of lime salts in the water. The calcium salts, e.g., chlorinated lime (bleaching powder) react with the soap, producing the insoluble dirty-looking scum seen on all hard waters—calcium stearate, &c. This lime soap floats, and can be recovered by the apparatus used to recover the waste grease.

In the course of experiments conducted in camp this summer, it was found that the soapy wash water could be freed completely of the dissolved soap by adding quantities of bleaching powder, the resulting effluent being bright, clear and sparkling, and smelling more or less of chlorine. This effluent was quite fit to be discharged into any soakage pit, drain or ditch without causing a nuisance. In this respect it differed greatly from the original soapy water. There is room for much experimental quantitative chemical work in relation to this and other waste products incidental to camp life and messing. There ought to be no difficulty in disposing of the calcium stearate to soap works.

INTESTINAL PROTOZOA IN SALONIKA WAR AREA.

By Lieutenant W. ROCHE.
Royal Army Medical Corps.

During the months of August, September and October, 1916, I had the opportunity of examining the stools of 893 cases of diarrhœa and dysentery among the troops of the Salonika War Area.

Some of these cases had their stools examined two or three times weekly, but the great majority of them not more than once.

This work was all part of the routine laboratory examination of stools of patients suffering from diarrhœa or dysentery in three of the general hospitals in this area.

Troops of the Salonika zone of the Eastern Mediterranean have suffered severely from diarrhœa and dysentery. These infections started about the month of May, 1916. They have continued, with slight variations, up to the present. These variations, I think, are mainly due to climatic changes. The great spreaders of diarrhœas and dysenteries are flies. Heat and moisture are necessary for these pests to thrive. In the very hot spells, when everything was dried up, flies became less numerous. During a cold spell, their numbers were markedly diminished and in these periods there was decidedly less diarrhœa and dysentery.

Bacillary dysentery was the predominant type but there were quite a number of acute amœbic cases. It is a remarkable thing there were not more, inasmuch as many of the troops, particularly those which had come from Gallipoli and Egypt, were carriers of *Entamœba histolytica.*

Microscopical examinations of the stools of these troops in Egypt, Malta and Salonika continually showed evidence of this.

TABLE OF FINDINGS.

Number of cases examined 893
Number of examinations 1,425

E.F.	Non-pathogenic Amœbæ 81		Pathogenic Amœbæ 84				Flagellate Protozoa 217						Coccidia 18	
	E. coli	*E. coli* cysts	*E. histol.*	*E. hist.* cysts	*E. minuta*	*E. min.* cysts	Lamblia	Lamblia cysts	Tetramitis	Tetram. cysts	Trichomonas	Cercomonas	Cocci isospora	Cocc. eimeria
39	42	39	21	16	29	18	29	44	72	18	45	9	15	3

By E. F. (free amœbæ), we mean amœbæ found in fresh specimens of stools, in a resting or precystic stage. This group includes cases in which there was no time for staining, nor was further examination possible for a more complete diagnosis.

Amœbic Dysentery.—As is seen in the above table, *E. histolytica* was present in thirty-seven cases. In two of these they were found "post mortem." In one, the patient died two hours after admittance to hospital. There were six perforations in the large gut, and typical lesions of acute amœbic dysentery, from which different scrapings showed large numbers of *E. histolytica.* This patient had never been in Egypt or Gallipoli or other infected area, and he did not belong to a Division that had been in one, nor was he in camp with any troops known to be infected.

The second case died from sepsis, the result of a severe gunshot wound of the thigh. In the routine post-mortem examination of the organs, the gut showed signs of acute amœbic dysentery and scrapings from it showed *E. histolytica.* This patient had also never been in any infected area.

In cases where *E. minuta* was found, a history of recurrent diarrhœa was usually given. The stools were fæcal with mucus, but seldom was there blood. These patients, one generally found, had been in Gallipoli or in Egypt.

As well as the *E. minuta*, but included in the Table under that category I found, in a few cases, a specially small form of amœba with its cyst, a type which had been demonstrated to me in Egypt by Colonel Wenyon, and which has been described by him.

Cases where any type of *E. histolytica* were found in the stools were treated in the ordinary way with emetine (one grain hypodermically daily for twelve days).

War time exigencies did not allow of all patients being retained in hospital after their course of treatment was concluded, so that further examination for cysts was impossible. Seven patients, however, in whose

stools *E. histolytica* cysts were found to persist after their emetine course, were further treated with Dale's double iodine of emetine and bismuth. These cases will be discussed in another paper.

Eight of the *E. histolytica* patients had also a bacillary infection. In all but one, it was of the Flexner type.

Ambœbæ coli, considering how commonly they are found in the gut, may be said to have been present only in a small percentage of cases.

Flagellate Protozoa.—In almost all cases where any of the flagellate protozoa were found, there was mucus mixed with fæcal matter; in a very few cases there was blood and mucus only,

Tetramitus mesnili was the flagellate most commonly present, more often in its flagellate than in its cystic stage. This was due, I think, to the fact that the patient's stool was examined soon after the diarrhœa commenced and before the slowly-forming cysts had time to develop.

Repeated examinations of the stools were not possible, but in patients who remained in hospital for some time, and in whom further search could be made, tetramitus cysts were found.

Lamblia intestinalis was a common infection, the cystic form being more often present than the flagellate form. This is due, I think, to this fact, that lamblias attaching themselves by their suckers to the mucous membrane of the duodenum and jejunum are difficult to detach therefrom by the action of drugs. On the other hand their cysts, which are free and mixed up with the intestinal contents, are readily washed down by aperients.

Five of the cases of lamblia infection I was able to examine weekly during three months, and despite all treatment they continue to discharge lamblia cysts up to the present time,

Trichomonas was found in comparatively few cases. This is peculiar as this parasite is so often present in the stools of people living in tropical and sub-tropical climates.

In one case where I found trichomonas and cercomonas flagellates in the stools of a patient who subsequently died from pyæmia, these flagellates were found post-mortem, both in scrapings from the large bowel and in the fæcal contents.

Coccidia were found in eighteen stools. In this infection mucus was always present in the stools. As a rule these parasites disappeared within a few days, but in one patient they were found in daily examinations for three weeks.

The lamblia and tetramitus infections were the most difficult to get rid of. Calomel, bismuth, thymol, salol, turpentine, emetine and Dale's double emetine were amongst the drugs tried, without any result.

Rectal irrigations with quinine, turpentine, eusol, did not lessen the infection.

At present acetazone and sour milk are being tried, but it is too soon to say with what results.

REPORT ON SIX CASES OF *AMŒBA HISTOLYTICA* CARRIERS TREATED WITH EMETINE BISMUTHOUS IODIDE.

BY CAPTAIN C. G. IMRIE.
Canadian Army Medical Corps.
AND
LIEUTENANT W. ROCHE.
Royal Army Medical Corps.

THE introduction of emetine in the treatment of amœbic dysentery marked an important advance in the treatment of this disease. In its action on the *Entamœba histolytica*, this alkaloid enjoys the rôle of a specific. However experience has shown that emetine as it is at present employed does not always affect the destruction of this protozoan in its encysted stage. Thus convalescents may continue over a considerable period of time to pass these cysts, which, as we know, are capable of transmitting the infection. From an epidemiological, as well as a medical point of view, the desirability of accomplishing the destruction of the entamœba in the encysted stage is quite obvious.

It has been suggested by Dale that the failure of emetine, by hypodermic administration, to destroy the cysts of entamœba may be due to the presence of the latter in healed pockets or sinuses, and thus more or less completely shut off from the circulation and tissue fluids of the body, and in support of this hypothesis he mentions the alleged superior efficacy of earlier treatment with ipecacuanha by oral administration.

He[1] has introduced a compound of emetine and bismuth iodide for oral administration, with which to obtain the advantages of the ipecacuanha and yet avoid its pharmacological action. He has reported promising results in cases treated with this double salt.

The presence of some cases of amœbic dysentery in 4th Canadian General Hospital provided an opportunity to study the action of emetine bismuth iodide. The observations on which this report is based were made upon six cases, all known to be carriers of *E. histolytica* cysts. Of much additional interest is the fact that four of these cases had been previously subjected to a course of emetine hydrochloride (daily doses of one grain hypodermically for ten or twelve successive days) in this hospital, and notwithstanding this treatment continued to pass cysts in the fæces.

The emetine bismuth iodide was administered in doses of three grains on twelve successive nights. When given immediately after the light supper which the patients have at 7 p.m., its administration was always followed with nausea and in some cases vomiting. These undesirable symptoms were least in evidence when the patients received the drug with water at 10 p.m.

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[1] *Note.*—This drug was first prepared and its use as a means of oral administration of emetine suggested by Du Mez (*Philippine Journ. Sci.* (B), x, p. 73, 1915).

In the following protocols, a tabulated report of the protozoological findings is given:—

Case 1.—D., aged 24, left England, October, 1915. In July, 1916, he was troubled with diarrhœa which continued at intervals and finally caused his entrance to hospital in August. Received emetine one grain hypodermically from August 20 to August 30.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba coli*	*Entamœba coli* cysts	*Entamœba histolytica*	*Entamœba histolytica* cysts	*Lamblia*	*Lamblia* cysts	*Coccidia*
Aug. 8	Brown unformed	x	x	—	x	—	—	x
,, 17	,, ,,	x	x	x	x	—	—	x
,, 23	Liquid mucus ..	—	—	—	—	xxx	xxx	—
,, 24	Brown unformed	x	x	x	—	x	xx	x
,, 30	,, ,,	x	x	x	x	—	—	—
,, 31	,, ,,	x	x	—	x	E.B.I. nightly till Sept. 12		
Sept. 2 to Sept. 9	,, ,,	No protozoa		—	—	—	x	—
,, 10 to Sept. 15	Brown unformed with mucus	—	x	—	—	—	x	—
,, 15 to Oct. 14	Brown unformed	*Amœbæ coli* and *A. coli* cysts on various days but no other protozoa.						

Case 2.—T., in Gallipoli April, 1915. In July became ill with dysentery and was sent to Hospital where he was treated with emetine. In May, 1916, when in Egypt had an attack of dysentery, and was sent to a General Hospital and treated with emetine. In July, 1916, was admitted to a General Hospital in this area.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba histolytica*	*Entamœba histolytica* cysts	—
Aug. 8	Light brown fæcal and mucus	x	x	From Aug. 6 to 18 was treated with emetine 1 gr.
,, 9	Brown unformed ..	x	—	—
,, 21	,, ,, ..	—	x	—
,, 29	,, ,, ..	x	—	—
,, 30	,, ,, ..	x	—	E.B.I. daily till Sept 12
,, 31	,, ,, ..	x	x	—
Sept. 1 to Oct. 14	No amœbæ or cysts were found in stools, which were brown and unformed. This patient had also a tetramitus infection which disappeared on Aug. 31.			

Case 3.—S., had dysentery in Gallipoli October, 1915; was given twelve to sixteen injections of emetine. Admitted to hospital in this area on August 17, 1916, with diarrhœa.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba histolytica*	*Entamœba histolytica* cysts	—
Aug. 17	Brown unformed ..	x	x	August 17 to 29, emetine, hypodermically, 1 gr. daily
,, 30	,, ,, ..	x	x	—
,, 31	,, ,, ..	x	x	--
Sept. 1	,, ,, ..	x	—	August 31, emetine B.I. commenced
,, 2 to Oct. 14	—	No protozoa		—

This patient had a tetramitus infection.

Case 4.—G., had dysentery in Egypt in 1915. Had diarrhœa at intervals between January and August, 1916. Admitted to hospital August 5, with diarrhœa.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba histolytica*	*Entamœba histolytica* cysts	—
Aug. 6	Brown unformed ..	x	x	Aug. 7 to 15, emetine, 1 gr. daily hypodermically
,, 12	,, ,, ..	—	x	---
,, 29	,, ,, ..	—	x	Aug. 31, E.B.I. commenced
,, 31	,, ,, ..	—	x	—
Sept. 3 to 14	—	No protozoa		—

This patient had a tetramitus infection.

Case 5.—S., admitted to hospital September 14, 1916. Had no previous history of dysentery, nor had he been in an infected area.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba histolytica*	*Entamœba histolytica* cysts	—
Sept. 15	Fæcal with little blood and mucus	x	x	Sept. 15, E.B.I. commenced
,, 19	Brown unformed, mucus	x	x	—
,, 21	Brown unformed ..	—	x	—
,, 22 to Oct. 20	—	No protozoa found		—

Case 6.—H., had no previous history of dysentery.

TABLE OF FINDINGS.

Date	Type of stool	*Entamœba histolytica*	*Entamœba histolytica* cysts	—
Sept. 25	—	x	—	E.B.I. commenced
„ 26	—	x	—	—
„ 27 to Oct. 20	—	No protozoa found		—

As is shown in the preceding protocols, five of the cases ceased to pass *E. histolytica* in the active or encysted form, forty-eight hours after the institution of treatment. The sixth case continued to pass cysts for six days, after which the microscopical findings were negative.

These observations have a greater significance when it is remembered that four of the cases had previously received a course of emetine hydrochloride, despite which they continued to pass the entamœba in its active or encysted stage.

Our observations in these six cases confirm the results obtained by Dale[1] and subsequently by Low and Dobell.[2]

Note.—Through the kindness of Lieutenant-Colonel Dudgeon we were able to obtain the double salt.

NOTES ON THE USE OF FLAVINE AS AN ANTISEPTIC IN COLONEL PILCHER'S WARDS IN THE QUEEN ALEXANDRA MILITARY HOSPITAL.

By Temporary Lieutenant V. C. JAMES.
Royal Army Medical Corps.

Flavine compounds were brought to our notice about six months ago, and we had the opportunity of examining the experimental results which have subsequently been published by Browning, Kennaway, Gulbransen and Thornton, and which indicated that flavine was an antiseptic of remarkably high potency against the usual pyogenic organisms, while at the same time it did not suffer reduction in effectiveness in the presence of serum. Combined with those properties was the further excellent feature that a powerfully bactericidal solution (e.g., 1 in 1000 in normal saline) did not interfere with phagocytosis or damage the tissues in any way. Since then cases have been treated with flavine compounds in Queen Alexandra Military Hospital, the great majority of them being wounds acquired on service. They varied between slight and severe injuries, but in all cases a definite infection accompanied by suppuration

[1] *Lancet*, July 29, 1916. [2] *Ibid.*, August, 1916.

was present. Owing to the small quantity available up to the present, we have as yet only employed the antiseptic on a modified scale, but our observations have been sufficiently promising to hold out hopes of great improvement in the results of wound treatment in the future. The treatment which we have carried out has lain along the following lines: the wound has been thoroughly cleansed with either normal saline or a mixture of equal parts of normal saline and hydrogen peroxide solution. After mechanical removal of as much exudate, pus and slough, as was possible by this way, the wound was swabbed out with 1 in 1000 flavine, a few cubic centimetres of the antiseptic were left in the wound to absorb, and the whole was finally covered with gauze soaked in flavine solution, the latter being then covered with a piece of waterproof protective to prevent evaporation. We have carried out this procedure twice a day. The results thus obtained have been highly satisfactory. It has been noticed in cases which had been discharging pus abundantly for weeks under other forms of treatment, that within forty-eight hours the discharge of pus was greatly diminished. In cases where no comparatively inaccessible focus of infection was present, such as dead bone or a foreign body, we have come to anticipate a clean wound in four or five days. By this time we expect to see the wound lined by granulations; these are small, pink in colour, firm and do not bleed readily on swabbing. We have noticed a very definite contrast between the granulations which appear in the presence of flavine and the flabby type of granulations of low vitality which we have seen following the use of other antiseptic solutions.

It has also been observed that in cases treated with flavine the epidermis tends to grow in over the granulating surface with remarkable rapidity, the rate of advance being much greater than was ever observed by us either after treatment with physiological saline alone or with other antiseptics. We consider that this affords a valuable demonstration of the non-irritative and non-toxic properties of flavine. This absence of harmful effect on the epidermis is paralleled in the case of other tissues. We have frequently left as much as ten cubic centimetres of 1 in 1000 solution of flavine in wound cavities, all of which has been absorbed, and we have observed nothing but good result locally from the procedure. Even if the treatment be continued over a number of weeks there is complete absence of any general toxic reaction on the part of the patient.

The following are some striking cases which, we believe, illustrate what is the rule in the treatment of infected wounds with flavine.

Lieutenant A.: Gunshot wound of leg, fractured femur; amputation. The stump was heavily infected. It had been dressed for six weeks principally with saline without improvement resulting. During this period eusol had been occasionally employed but without any good effect. The wound was then washed and packed with gauze soaked in flavine 1 in 1000. After three weeks' treatment the leg was sufficiently healthy

for re-amputation to be performed; skin flaps were then made and sutured, flavine dressing being continued; they healed by first intention.

Lieutenant L.: Gunshot wound of arm, with fracture of radius, ulna and humerus amounting practically to ablation of the elbow. After treatment for a fortnight with saline dressings the wound remained very septic. Syringing with hydrogen peroxide solution twice daily for over a week caused no improvement. After six days' irrigation with flavine the infection showed very marked diminution, although complete healing was prevented by sequestra; the wound has since granulated and has been covered by epidermis with remarkable rapidity.

Lieutenant E.: Superficial wounds of arm and leg, both heavily infected. These had been treated for fourteen days with normal saline but had made little progress. Within two days after commencing flavine treatment the wounds were clean and granulating, and healing was uninterrupted.

Lieutenant T.: Large carbuncle on neck. It had been incised before admission, but was discharging pus very freely, and showed a large amount of slough at the base. After six days' treatment with flavine all discharge had ceased and the surface was rapidly covered by the ingrowing epidermis. The progress in this case was remarkable.

Lieutenant G.: Gunshot wound of leg, with fracture of tibia, and a large gaping defect of the soft tissue. The skin and tissues around were extremely damaged. An anæsthetic was given and necrosed bone and foreign bodies were cleared out. The wound was then washed out twice daily with hydrogen peroxide and saline, followed by flavine, about an ounce of the flavine solution being left in the cavity at each dressing, the wound then lightly covered with gauze soaked in flavine. After two days the temperature, which had been 101° F., became normal and remained so.

Lieutenant D.: Scalp wound received forty-eight hours before admission The wound had previously been sutured. On admission an area three inches square was bulging. The stitches were removed and a quantity of pus evacuated. The cavity was washed out and packed with gauze soaked with flavine. In four days there was no more pus, and in ten days the wound had healed completely.

To sum up, the types of cases in which we have employed flavine have been the following: compound fracture (twenty-five cases), reamputation of infected amputation stumps (five), lacerated gunshot wounds of the soft tissues (twenty-five), and in numerous severe minor septic infections such as perineal and ischio-rectal abscesses, axillary abscesses, carbuncles, and infections, with extensive sloughing of soft tissues and tendons. The rapid progress of these minor septic infections, which although not serious in themselves are so wasteful in the time of personnel, has been most striking.

We are convinced that as compared with other forms of treatment,

e.g., saline application, peroxide of hydrogen and eusol, flavine leads much more rapidly to the extinction of infection as evidenced by the disappearance of suppuration; at the same time the processes of repair in the form of granulation tissue growth and superficial extension of epidermis occur with a degree of rapidity which we have not seen equalled under any other circumstances. A further practical outcome which is of the greatest consequence is that the use of flavine shortens very naturally the stay of patients in hospital—a most important factor, when large numbers of cases have to be dealt with. In our opinion flavine constitutes an exceedingly valuable addition to the armamentarium of the surgeon in the treatment of septic wounds, and as a therapeutic agent is much superior to anything of which we have had experience

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ARMY DENTAL TREATMENT IN WAR TIME.

By Captain J. P. HELLIWELL.

Inspecting Dental Surgeon, London District.

In dealing with this subject it is not my intention to discuss Army dental treatment in its highest form as it could be practised when time was no great object, but to do so with the knowledge that just now it is essential to render all men fit in a dental respect with the least possible delay. A broad view has to be taken of the situation, for the average man of service age has not had the advantage of school dental clinics in his younger days, with the result that most of the men at present in the Army have been totally neglected in that respect. It is well known that if a list is required of men in almost any unit who have some kind or other of dental defect, practically all that would be necessary would be the preparation of a nominal roll of the unit. With such a state of affairs, and bearing in mind the fact that, in spite of dental defects, men go about their work and eat heartily in normal times, it would obviously be wrong to propose such a perfection of treatment as would not only cause a considerable delay in the training of each man but would also have a very serious effect in the timely production of drafts. At the same time sufficient should be done for the men to obviate as much as possible the risk of toothache and to eliminate such septic conditions of the mouth as are likely to be detrimental to health; and lastly, in those few cases where they are absolutely necessary for efficient mastication, to supply artificial dentures.

In carrying out treatment it would be well to remember that general disturbances due to or aggravated by dental conditions are those in which oral sepsis is prevalent and are not to any great extent dependent on deficiency of teeth. In the first place, the dental officer should thoroughly realize that his work is to ensure men being able to masticate efficiently, and to disregard the "beauty specialist" aspect of his profession. He

must take a firm stand in this respect and not be too much influenced by the wish of his patients. We all know that half our patients care about very little else than the appearance of their front teeth and are very apt to disregard those that "do not show," and it is no uncommon thing for medical officers to be influenced by like considerations and appeal to our sentiments in this respect. The question now arises as to where we must draw the line. The men who are fit and liable for general service or garrison duty abroad must be our first care. It is quite within our power to render all these men dentally fit, but the urgent need of men limits considerably the time we are justified in expending upon them. If the supply of dentures were undertaken to any large extent, it would be impossible for a whole army of dental surgeons to deal with the men satisfactorily in a reasonable time, for we would then have to wait patiently for what is commonly called the "setting of the gums," but what is really the absorption of the alveoli. This absorption is a process which may take any time from two months to two years to complete, and goes on long after the gums have healed. It has been usual in the Army to fit dentures within three months after the extraction of the teeth—a proceeding which very often results in the plates having to be remade when further absorption has taken place and, consequently, additional work given to the dental staff. It is quite obvious that the provision of dentures should be avoided wherever possible, and it is here necessary to say that it is not possible to make any definite rules as to the number of teeth a man must have lost before he can be recommended for dentures. This depends entirely on his state of health. If a man is physically fit in all respects I cannot imagine that the cleansing of the mouth is going to make him any less fit. We too often make the mistake of feeling that it is our duty to replace the teeth we extract although we know that the operation is performed because the teeth extracted are detrimental to health. We daily find men who are practically edentulous the picture of health and able to digest all kinds of food. The sole reason is that the mouths are clean. Efficient work can be done by three or four sound opposing teeth, not necessarily molars, in each jaw in a clean mouth. Another point which is also apt to be overlooked is the great use of the tongue in mastication. One is generally quite unconscious of the power of this organ against the hard palate in the trituration of food and its great use in the thorough mixing of saliva with the food.

As regards treatment the dental surgeon should in each case first ask himself "is it essential for this man to be fitted with a denture, or can I make him dentally fit by judicious surgical treatment?" I am convinced that in very few cases are dentures absolutely essential, and that the physical condition of a man should always be the sole guide to their supply.

Functionless septic stumps should be removed without hesitation, as their removal does not lessen the masticating area and they are the greatest cause of oral sepsis.

As regards *functional* teeth and stumps everything possible should be done to treat them and render them healthy if we are able by so doing to prevent the delay incident on the provision of dentures. It is far more economical in all ways that a dental surgeon should spend a whole day if necessary in the treatment of the mouth of a man, than that the man shall be kept back from service for dentures which may not be satisfactory. Where dentures are quite essential too much time should not be spent in the attempt to save "dead" teeth, unless they are absolutely necessary to hold up the plates, and obviously no stumps of any description should be retained in such cases.

Whatever treatment is undertaken it is essential that men should be urged to take an interest in their own mouths and use their toothbrushes regularly. This should be impressed upon the men by company officers and by the medical officers attached to units, who should see that their instructions are properly carried out. Dental officers always do their best in this respect as they realize how hopeless dental treatment is without the co-operation of the men, and company and medical officers could do more as they are in closer touch with the men and consequently have much more influence over them.

To summarize I would give the following rules for dental treatment. These I consider are a guide to essential treatment at a time when delay is a very serious matter.

(1) Decide at once whether a man can be made fit without dentures, always bearing in mind his physical condition and the fact that cleaning up his mouth is going to improve his health whether he has dentures or not.

(2) Get rid of *functionless* septic stumps and teeth. Remove tartar, debris, etc.

(3) Treat wherever possible *functional* teeth and stumps in all cases where dentures are not essential.

(4) Remember that ill health caused by or aggravated by dental conditions depends much more on the prevalence of sepsis than on actual deficiency of teeth. This can be observed daily.

(5) Do not be influenced by a patient's loss of front teeth if he has sufficient other useful ones. Efficiency is aimed at. If dentures are supplied when they are not absolutely essential they are often a positive hindrance, and tend to make the wearer "bolt" his food. Also, under service conditions it is not always possible to keep these appliances as clean as is desirable, with the result that they often become foul from the accumulation of particles of food, and so not only increase the possibility of caries occurring in the remaining natural teeth but, almost without exception, cause a more or less severe form of diffuse stomatitis.

(6) Aim mainly at the cleansing of the mouth. In this the co-operation of the patient is quite necessary and I consider company and medical officers could do very much more than they now do in seeing that men under their care do not neglect the use of the toothbrush.

Review.

MILITARY SURGERY. By D. P. Penhallow, S.B., M.D.(Harv.), Chief Surgeon American Women's War Hospital, Paignton, Captain Medical Corps, Massachusetts Guard, etc. London: Henry Frowde. XVI, pp. 432. 1916. Price 15s. net.

A book on "Military Surgery," written from the experience of an American surgeon, gained in an English base hospital, should appeal to all surgeons similarly placed; but we must confess to some disappointment that the work has not been confined to actual experience gained at Paignton, instead of an attempt being made to embrace the whole subject from the time of the immediate wound, the initial treatment of which must depend upon the views of others, and which are not always generally accepted.

Dr. Penhallow writes with that dogmatism which we associate with American authors, and lays down rules for treatment with the emphasis of long experience which are often open to criticism. Here we find it advocated that in many wounds of very recent date primary suture should be adopted after the method described by Colonel Gray, but the experience of a base hospital has shown so many disasters from this treatment that we are surprised to see it given so much prominence, especially after the discussion on infection of wounds with anaerobic organisms, which, by the way, contain an unusually large percentage in which *Bacillus tetanus* is found present. The subject of tetanus is discussed in four pages, one of which is occupied by an account of the methods of using magnesium sulphate, which has already been given up. Intrathecal injections of antitetanic serum are merely mentioned for use "in the more advanced cases." There is no mention of consecutive prophylactic doses of serum, or of those cases so frequently occurring of tetanus localized in one limb.

The article on foreign bodies in the tissues is well written and summarizes the principles under which the removal of a foreign body is to be advised; but it is rather surprising to find that Dr. Penhallow is content to rely on the fluorescent screen for the localization of foreign bodies, and that this method alone is used at the American Women's War Hospital.

Chapter VII is devoted to wounds of joints, and contains many useful points, amongst which it is gratifying to note the author's preference for extensive opening and drainage of the joint, obtained, if necessary, by excision of the comminuted articular surfaces; but he limits this operation considerably in the case of the elbow joint in which, of all joints, it is the most useful. The article on gunshot wounds of the knee-joint, in which drainage is often so unsatisfactory, is disappointing.

Chapter VIII, however, dealing with injuries to long bones, is one that amply repays close study. Here the author has emphasized the fact which so many surgeons have been slow to learn, namely, the importance of leaving in situ every piece of bone in a comminuted fracture, which possesses any periosteal covering or attachment, and to leave all doubtful pieces until it is definitely proved they are no longer viable, or until sequestration takes place. If this lesson alone was learnt from the book, the author would save much meddlesome surgery, and probably also many malunions in complicated fractures. The gunshot fracture of

each long bone is fully discussed with various modes of treatment, and if criticism were needed, we would suggest a greater prominence be given to methods of applying extension to a long bone in these fractures, as, for instance, in the methods of Hy. Groves.

Dr. Penhallow has the courage of his convictions in advocating in certain cases the fixation of the fragments in an infected gunshot fracture by means of a bone-plate. He gives adequate reasons for his teaching, and refutes the claims of those who have condemned the operation that necrosis is increased, union delayed, and convalescence prolonged, by reference to cases under his care. We are entirely in accord with Dr. Penhallow in his teaching on this subject, but would insist that a due selection of cases be made, and due regard for technique and after-treatment.

The chapters on wounds of the head, thorax, and trunk contain nothing new, and are chiefly the expression of opinion of those working in France; whilst the chapter on wounds of the spine is very short and inconclusive.

Chapter XI is devoted to wounds of peripheral nerves, and the author here places a paralysis of part of a limb due to a nerve contused by direct contact with a projectile as a physiological loss of conductivity. He passes over the symptoms of nerve injuries in a few words without reference to epicritic or protopathic losses of sensation, and with no reference to electrical reactions other than loss to faradism. The treatment of nerve lesions is much better discussed than the symptoms or indication for operation.

The book is well printed, well illustrated by notes of actual cases, and contains many copies of radiographs, photographs of gunshot injuries. It would seem better, however, if it had been compiled upon the experience gained at Paignton by American methods as contrasted to those of English surgeons.

Current Literature.

German Medical Congress at Warsaw. [Proceedings of an Extraordinary Meeting held at Warsaw on May 1 and 2, 1916 (Verhandlungen der ausserordentlichen Tagung des Deutschen Kongresses für innere Medizin in Warschau am 1 und 2 Mai, 1916)].—The members of the Congress were received by General von Bessler, the temporary Governor of Warsaw, and the business of the meeting opened with an address by Surgeon-General His.

Numerous papers read and discussed at the Congress included several dealing with cholera, typhus fever, typhoid and paratyphoid fevers, and dysentery, with special reference to the occurrence of these diseases during the War amongst the civil and military populations.

(I) *Cholera.* — Dr. W. Hoffmann (Berlin) gave a history of the incidence of cholera since the commencement of the War, and referred to the results of protective inoculation. Cholera had shown itself at Constantinople and Adrianople during the first six months of the year 1914, and in July the disease broke out in the Russian Provinces of Volhynia and Podolia bordering on Galicia. In August some cases occurred in Warsaw. The disease appeared early in the Serbian Army;

by the end of September, 1914, there had been some 12,000 cases, and fresh cases were occurring at the rate of from 200 to 300 cases daily. Coincidently with the Russian invasion, and later more particularly in connexion with Russian prisoners, infection appeared amongst the Austro-Hungarian troops. By the end of 1914 there had been 22,000 cases with 7,672 deaths; 9,353 of these cases, with a case-mortality of 50 per cent, occurred amongst troops in Galicia. During the second year of the War, up to September, 1915, there were 26,000 cases of cholera amongst Austro-Hungarian troops with 15,000 deaths, representing a case-mortality of 57 per cent. During this second period eight-tenths of the cases occurred in Galicia. The incidence of infection amongst the German army which was co-operating with the Austro-Hungarian troops in Galicia is referred to later. Meanwhile there had been serious prevalence of cholera amongst the "Y" German Army which had marched on Russian Poland. The first cases of cholera amongst these troops occurred in November, 1914, and there were cases amongst the Russian prisoners at the same time. Amongst the latter there were, from the commencement of the War up to November, 1915, altogether 3,166 cholera cases. The actual number of cases amongst German troops is not given, but the percentage figures given show the following incidence for all the German armies from the commencement of the War up to January, 1916:—

	Rate per 10,000 men
Cases of cholera in the Field Army	6·5
,, ,, ,, Reserve Army	0·5

During the period ending January, 1916, there were only seventy-eight cases of cholera amongst the German civil population, distributed over thirty different localities. There were two periods of serious epidemic prevalence amongst the German troops, with maximum incidence for the first outbreak in December, 1914, and for the second outbreak in August, 1915. The "Y" Army outbreak in November, 1914, has been mentioned, but details as to incidence are not given. The second outbreak occurred in Galicia and the "break-through" at Görlitz. Immediate inoculation of the "X" Army was ordered in July, 1915, but the number of cases continued to rise until the middle of August. The epidemic then declined, and cholera had disappeared by the beginning of December. The epidemic prevalence of the latter half of 1914 is spoken of as involving the "Y" Army in Russian Poland chiefly, but the following figures show that the "X" Army also suffered somewhat heavily during this period:—

	Rate per 10,000 men
Cholera cases in the "X" Army in the East:—	
In the first three months (July to October, 1914) of the War ..	52
Up to the disappearance of cholera in December, 1915 ..	61

The western front of the German army remained nearly free from cholera during the period referred to. In spite of frequent movement of troops from east to west only thirteen cases altogether occurred on the western front, and these amongst three divisions which had been transferred from the east. Some statistics as to the frequency of "carriers" are given. Thus Baerthlein found that the carriers in the prisoners' camp at Hammerstein occurred in the proportion of 24·8 per cent of the number of actual cases of actual illness.

It appears that protective inoculation was not carried out effectively in the earlier days of the campaign. The rapid movements of troops would

not permit of systematic inoculation; but orders were issued that inoculation should be practised, whenever possible, on the outbreak of cholera or when the troops were in a dangerous area. At any rate, by October, 1914, means for inoculation were already provided for all the troops; and it is stated that many were already vaccinated when the first cases appeared in the Eastern Army in 1914. Kolle's vaccine, 2 m. grm. of culture from agar emulsified in one cubic centimetre of normal saline and heated at 58° C. for sixty minutes, would appear to have been used at first. A dose of two cubic centimetres was used for the second inoculation. It is stated that for the official vaccine used at the time of the discussion a strain of cholera bacillus of maximum immunizing activity and with minimum inflammatory properties had been selected, and that sterilization was effected at a temperature between 53° and 55° C. When the two doses cannot be given, a single dose of from 1·5 to 2 cubic centimetres is advised. There had not been any serious reaction after the two ordinary doses, and the scarlatiniform rash described by Friboes as occurring three or four weeks after inoculation had not been observed. Also fear of the effect of a negative phase following inoculation has proved to be groundless; it is stated also as the result of experience in the Austrian Army, that inoculation has a satisfactory therapeutical effect. The general conclusion as to the prophylactic value of inoculation during the War is distinctly favourable. There is, however, considerable difference of opinion as to the length of time over which the protective influence of the vaccination remains effective. Kolle considered that the serum showed but little loss in protective bodies for at least a year. Barykin, on the other hand, found that the protective action was at its maximum fourteen days after inoculation, and disappeared within from seven to nine months. Hoffmann has not been able to find any protective bodies in the serum after six months, and advises that there should be a second vaccination at the end of that period.

The effect of vaccination on the case-mortality was discussed. In the Russo-Japanese war the cholera case-mortality was 42·5 per cent amongst the inoculated, and 75 per cent amongst the uninoculated. During the present War, the case-mortality in the Reserve Army (inoculated) has been 24·26 per cent, and amongst the civil population (78 cases, none inoculated) 53·85 per cent. The case-mortality figures amongst the Field Armies, ratio of inoculated to uninoculated not given, have been: "X" Army, 33·45 per cent; "Y" Army, 35 per cent; and "Z" Army, 30·16 per cent. The case-mortality in the Austro-Hungarian Army has been, according to Kaup, 35·91 per cent.

The figures for the Greek Army during the Balkan War of 1912-1913, as given by Saras, were quoted:—

	Percentage of men attacked	Case-mortality per cent
Amongst whole army	1·9	—
Amongst those inoculated twice	0·7	10·2
Amongst those inoculated once	4·25	12·2
Amongst the uninoculated	9·29	27·5

In the course of the discussion of Hoffmann's paper, Ungermann questioned whether the protective activity of the serum was parallel with the titre of antibodies demonstrable. After the administration of cholera cultures by the mouth, animals were protected, although antibodies could not be demonstrated in the serum. Paltauf pointed out that the calculated case-mortality in cholera was influenced largely by the basis on which the diagnosis was made. If all slight cases of illness, in which

the diagnosis was based on bacteriological grounds only, were included, the case-mortality would be about 20 per cent. If well-marked clinical symptoms formed the basis of diagnosis, the case-mortality will reach 50 per cent. Kaup, referring to experience in the Austrian Army, was a firm believer in the prophylactic value of inoculation. The case-mortality amongst the inoculated varied from *nil* to 20 per cent; amongst the uninoculated it varied between 40 and 60 per cent. When inoculation against cholera is practised during the course of an epidemic, the number of cases is suddenly cut off some five to eight days after the inoculations. The protection conferred by inoculation does not last for more than three or four months, and antibodies are not to be found in the serum after then. In the Austrian Army re-inoculation is practised after three months if there is any danger of infection. For the purposes of re-inoculation a dose of at least two cubic centimetres of the official vaccine should be given; the dose of one cubic centimetre was not sufficient.

(*To be continued.*)

Correspondence.

[We have been asked to publish the following letter.—Ed.]

TO THE EDITOR OF THE "BRITISH DENTAL JOURNAL."

Sir,—As a dental surgeon, with two years' experience of work among the troops near the Front, I was delighted to read Captain Finn's paper in your issue of January 15. His remarks on the provision of dentures express my views exactly. There is far too much eagerness to "clear out" roots and decayed teeth, thereby putting the man "hors de combat" for a considerable time. A large proportion of these men subsequently fitted with dentures eventually carry the latter in their pockets or haversacks, where they get broken or lost, or break them on the first biscuit they attempt to eat. My plan has always been to preserve every scrap of tooth substance possible. Many a mouth, which at first view looks quite hopeless, when cleaned and the soft and decayed dentine cleared away, if the remaining cavities and roots are rapidly filled or capped with cement, after sterilization, can be rendered quite serviceable. and the man can carry on in comfort for several months. Half a dozen roots when opposed by teeth in the opposite jaw are of far more value out here than when replaced by the most perfectly-fitting denture. In my opinion it is waste of time and material to fit up middle-aged men with dentures who have not previously worn them, and who are proceeding to the Ffront.

I am, Sir, etc.,

C. L. Mackaness,

19, Hanover Square, W. *Captain Dental Surgeon, Att. R.A.M.C.*

Notice.—The blocks for the illustrations in the article on "The Surgical Anatomy of the Synovial Membrane of the Knee-joint," by Colonel A. Fullerton, which appeared in our February issue, were kindly supplied by the *British Journal of Surgery*.

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Original Communications.

CLINICAL AND LABORATORY RESEARCHES ON DYSENTERY IN EGYPT, WITH SOME REMARKS ON SANITATION.

BY CAPTAIN DAVID THOMSON.
Royal Army Medical Corps.

AND

CAPTAIN T. J. MACKIE.
Royal Army Medical Corps.

CONTENTS.

(1) Prefatory Note.

THESE investigations were carried on in the wards of No. 21 General Hospital, Alexandria, and in the Central Laboratory adjoining this hospital during the months of April, May and June, 1916. We wish to thank Colonel O'Sullivan, C.M.G., for giving us every facility and assistance in our studies, also Major Ferguson, officer in charge of the Central Laboratory, and Captains De Boer and Miller who were in charge of the patients placed at our disposal. Our thanks are also due to Sister Atkinson for her careful record of the charts in the cases investigated by us. We had intended to carry out a very thorough and elaborate research on 100 cases, but owing to the illness of one of us the work was cut short after the completion of thirty-seven cases. The cases were not specially selected. We simply investigated those which exhibited dysenteric symptoms, in that they had diarrhœa accompanied by blood and slime in the motions. Numbers of such patients were constantly being admitted into hospital, exhibiting symptoms more or less acute, sub-acute and chronic.

(2) Introduction.

In the early summer of 1915, after the commencement of the Gallipoli campaign, large numbers of soldiers began to be admitted to the hospitals in Egypt suffering from diarrhœa with blood and mucus. It was soon discovered that they were suffering from dysentery, and in July, 1915, it was clearly demonstrated by Captain J. G. Thomson and Lieutenant Bartlett, R.A.M.C., that the majority were cases of true amœbic or tropical dysentery, cases of bacillary dysentery being in the minority. Both amœbic and bacillary dysentery are endemic in Egypt, and there can be little doubt that these diseases were carried to Gallipoli by the troops which had been encamped in Egypt previous to the attack on the Dardanelles. It is quite possible also that both dysenteries were endemic on the Peninsula itself; Captain Archibald had this belief. After this important discovery as to the true nature of the disease, large quantities of emetine were quickly dispatched to the Peninsula on the advice of Lieutenant-Colonel Sir Ronald Ross, and soon after it was noticed that the cases admitted into hospital were much less severe and the mortality was considerably reduced. Indeed, due to this early administration of emetine a large reduction in the positive findings of amœbæ in the stools resulted. Bacteriologists were scarce and it was impossible to diagnose the type of the disease in every case by laboratory examination, but the general

routine treatment established was the injection of emetine; in the very acute cases injections of anti-dysenteric serum and saline treatment were also given. In the autumn, with the advent of the cold weather and the consequent diminution of flies, the disease showed a very sudden fall. At the end of the year the Peninsula was evacuated. During January, February and March, 1916, the disease was more or less in abeyance, nevertheless considerable numbers of cases continued to come into hospital. In April, May and June, 1916, the numbers increased considerably, due undoubtedly to the commencement of the hot weather with its accompanying increase in the number of house-flies. Emetine still continued to be the stock treatment, but amœbæ were seldom found, due possibly to the fact that this drug had always been injected early for some days before the patients were admitted to hospital. About the month of April, 1916, it was observed that the emetine treatment did not seem to have quite the curative effect which one would expect from a drug so specific, and on making a careful bacteriological investigation of the stools in these cases, it was found that a much higher percentage than heretofore were suffering from dysentery of a true bacillary type. This indeed was always the vexed question—Was the case amœbic or bacillary? For on this answer depended the treatment. A large number of cases were undoubtedly mixed, viz., amœbic + bacillary dysentery, and some were unfortunate enough to have an enterica infection as well. In the summer and autumn of 1915, Lieutenant Bartlett, R.A.M.C., put forward the suggestion that the great majority of all cases started as a true amœbic infection, and that the amœbæ having damaged the integrity of the mucous membrane of the large intestine, the bacillary types of the disease followed on as a secondary infection. He had strong support for this suggestion in the post-mortem findings, as nearly every case which showed a true diffuse bacillary ulceration of the large intestine showed also amœbic ulceration of an earlier date. In consequence in cases where amœbic ulceration had become established, a cure could not be guaranteed by emetine administration, since, although the amœbæ were quickly killed off, the secondary bacillary infection carried on the irritation and ulceration. He considered it possible that many intestinal organisms might take part in this secondary irritation and ulceration. In this idea he was supported by Captain J. Gordon Thomson and Lieutenant Magner, in that they often found cases of dysentery in which no amœbæ could be detected and none of the true bacilli of dysentery. In these cases it was considered

possible that the emetine treatment had killed off the amœbæ and that the irritation was carried on in the ulcers by a secondary infection of other bacterial organisms. Captain Willmore, R.A.M.C., was strongly opposed to this view of secondary infection and believed that cases were either truly amœbic or truly bacillary and that the bacillary types were able to arise primarily without previous amœbic ulceration. In November, 1915, Lieutenant-Colonel Sir Ronald Ross called together a meeting of the pathologists in Alexandria to see if any definite conclusion could be formed on this subject, and it was then decided that much further work and research was necessary before these important points could be finally settled. It seems likely that the necessary evidence will eventually be published by the various workers, and this paper is our contribution to that end. We look forward with interest to the publication of Lieutenant Bartlett's work, which is based very largely on post-mortem findings. He has found several cases in which, although no amœbæ could be found in the stools during life, yet amœbic ulcers were found to be present on post-mortem examination and, moreover, numerous amœbæ were demonstrated in sections of these ulcers. During the summer and autumn of 1915, practically all the pathologists and bacteriologists in Alexandria, and Captain Archibald working independently in the Island of Mudros, agreed that the great majority of the cases of dysentery were amœbic, and in consequence practically all were treated by emetine injections. Many were sent home to England after treatment and considerable numbers found their way into the hospitals in London, still suffering from the disease in a more or less chronic form. Of these home cases, Lieutenant-Colonel Ledingham concluded from agglutination and other tests that a considerable number were suffering from bacillary dysentery, while Lieutenant-Colonel Wenyon, as protozoologist, found that a considerable number were harbouring the cysts of *Entamœba histolytica*. It really amounted therefore to this, that the bacteriologists found a large number of cases to be bacillary dysentery, whereas the protozoologists found a large amount of amœbic dysentery. One can only conclude, therefore, that both the amœbic and bacillary types of the disease were very common and that in many instances the patients were suffering from both. Again in many other cases neither amœbæ nor true dysentery bacilli could be found.

(3) Analysis of Thirty Cases carefully investigated by the Authors.

All of these cases were very thoroughly examined by us during the months of April, May and June, 1916, bacteriologically, protozoologically and clinically. Freshly passed stools were examined very frequently by the microscope for protozoa and then immediately sent into the laboratory to be plated out for bacilli. At the same time a careful record was kept as to the treatment, temperature, etc. Our laboratory researches gave the following results:—

3 cases.	Atypical Dysentery Bacilli—Non-mannite-fermenters.
7 ,,	*B. dysenteriæ* "Flexner Y" group.
5 ,,	Atypical Dysentery Bacilli—Mannite-fermenters.
2 ,,	*Entamœba histolytica.*
5 ,,	*B. Morgan* No. 1 (present in large numbers).
2 ,,	*B. fæcalis alkaligenes* (present in large numbers).
2 ,,	*B. paracolon* types (present in large numbers).
1 case.	*B. proteus* (present in large numbers).
1 ,,	Streptococci (present in large numbers).
2 cases.	No unusual organisms found.
Total 30 cases.	

Additional Notes.—In one case from which an atypical *B. dysenteriæ* was isolated, large numbers of streptococci were also present in the fæces, and in one of the cases where *B. Morgan* No. 1 was isolated, *B. fæcalis alkaligenes* was associated with it.

Percentages of cases from these numbers are the following:—

B. dysenteriæ Flexner, Y group	25	per cent
Atypical *B. dysenteriæ*	26	,,
Entamœba histolytica	7	,,
B. Morgan, No. 1	16	,,
B. fæcalis alkaligenes	7	,,
B. paracolon	6	,,
B. proteus	3	,,
Streptococci	3	,,
Nil	7	,,
Total ..	100	per cent

Clinically, all were true dysentery cases, in that they had diarrhœa accompanied by blood and mucus, with a more or less febrile condition. In all instances the microscopic examination of the stools showed red blood cells, pus cells and epithelial cells. Yet after most thorough and repeated examinations only 58 per cent of them showed true organisms of dysentery (25 per cent of these being atypical forms) and in 42 per cent of the cases no dysentery organisms could be detected. In the majority of these negative cases, however, organisms which may be

considered more or less pathogenic and toxic were isolated—viz., *B. Morgan* No. 1, *B. fæcalis alkaligenes*, streptococci, *B. paracolon*, *B. proteus* and atypical *B. paratyphosus* B. Fifty per cent of the thirty cases had had emetine previous to their admission to our hospital, and sixty-two per cent of the negative cases had had emetine before admission and hence prior to our investigation. It is, therefore, quite possible that quite a number of the negative cases may have commenced with amœbic dysentery, but that the amœbæ had been killed off before they came under our notice. They still, however, exhibited dysenteric symptoms with the passage of blood and mucus, and it seems to us that this may be possibly explained by Lieutenant Bartlett's hypothesis—viz., the secondary infection of amœbic ulceration by such organisms as *B. Morgan* No. 1, *B. fæcalis alkaligenes* and streptococci, etc. Anyhow, it is not generally believed that the latter organisms can cause by themselves any ulceration of the large intestine with the passage of blood and mucus, so that one can only conclude, in the absence of true dysentery organisms, that ulceration had been first produced by a previous dysenteric infection, amœbic or bacillary, and that this ulceration with active symptoms was kept going, so to speak, by a secondary infection with one or other of the organisms mentioned. In any case it can hardly be denied that our researches have lent considerable support to Lieutenant Bartlett's contention. With regard to the absence of true dysentery organisms, in a large percentage of these cases it cannot be stated that this was due to delayed examination of the stools. The stools in nearly every case were examined fresh from the patient early in the course of the disease, but several grains of emetine had been injected in most cases before their admission to hospital. In this difficulty of finding true dysentery organisms to account for the disease we are not alone. From the *Tropical Diseases Bulletin*, vol. viii, No. 5, October 15, 1916, p. 299, we quote the following passage:—

"Under the Director, Dr. Henry Fraser, the subject of dysentery has received attention in the Kuala Lumpur Laboratory (Malaya). The stools of 123 cases of dysentery were examined. Of these forty-four were amœbic, sixty-seven were non-amœbic and twelve were not considered to be dysenteric. The non-amœbic or bacillary cases proved specially difficult of study. Dr. Fraser states that, even after months of practice, dysentery bacilli could only be isolated from about half of the cases of non-amœbic dysentery. The conclusion was arrived at, that the dysentery bacillus of

Flexner, the bacillus Y of Hiss and Russell, and Strong's bacillus are not distinct types. It is advised that these names be abolished. Dr. Fraser holds that in Malaya there are two types of bacillary dysentery; the less common is that caused by Shiga's bacillus, the more common is caused by a mannite-fermenting bacillus unnamed."

(4) Remarks on the Common Occurrence of Acute Diarrhœa in Egypt.

If a soldier or officer of our Army lived for many months in Egypt without having an acute diarrhœal attack he was considered lucky. So common were such attacks, especially during the hot season, that they became popularly known as attacks of "Egyptian tummy." These attacks varied more or less in severity. They lasted as a rule from two to five days and were accompanied with nausea and loss of appetite and often there was considerable fever, in some cases amounting to 103° F. The condition generally passed away quickly on starvation diet with the administration of castor oil and some laudanum, followed later by bismuth salts. The cause of this condition was undoubtedly some bacillus capable of causing considerable intestinal irritation and toxæmia. In one case a paracolon type seemed to be the offender; other cases were associated with *B. Morgan* No. 1, *B. fæcalis alkaligenes* and streptococci. Anyhow, is it not possible that such attacks following upon an early amœbic infection might produce a severe dysenteric disease with diffuse inflammation and irritation of the mucous membrane around the young ulcers? And is it not possible that on this account the dysenteric symptoms might continue even after the amœbæ had been killed off by emetine injections? Lieutenant Bartlett's post-mortem findings would seem to support this belief.

(5) Details of Three Cases of Dysentery (Atypical Dysentery Bacilli, Non-mannite Fermenters), with Charts.

Case 1.—J. F., aged 19. Dysentery. (Shiga, variant type.)

History.—He had dysentery at Suvla Bay and was admitted to hospital in Alexandria in November, 1915, where he received twenty injections (ten grains) of emetine.

Present Illness.—Has had diarrhœa since April 1, 1916. Emetine and magnesium sulphate started April 3, 1916. Abdomen tender all over. Motions very frequent.

Examination of Stools.—April 8, 1916. Fluid soft stools with little lumps of mucus, but no blood.

Microscopic Examination of Stools.—Some polymorphic cells found, otherwise very little cellular exudate. No amœbæ, but numerous trichomonas flagellates present. Fresh stools examined four times.

CASE 1.—J. F. (Shiga, variant type).

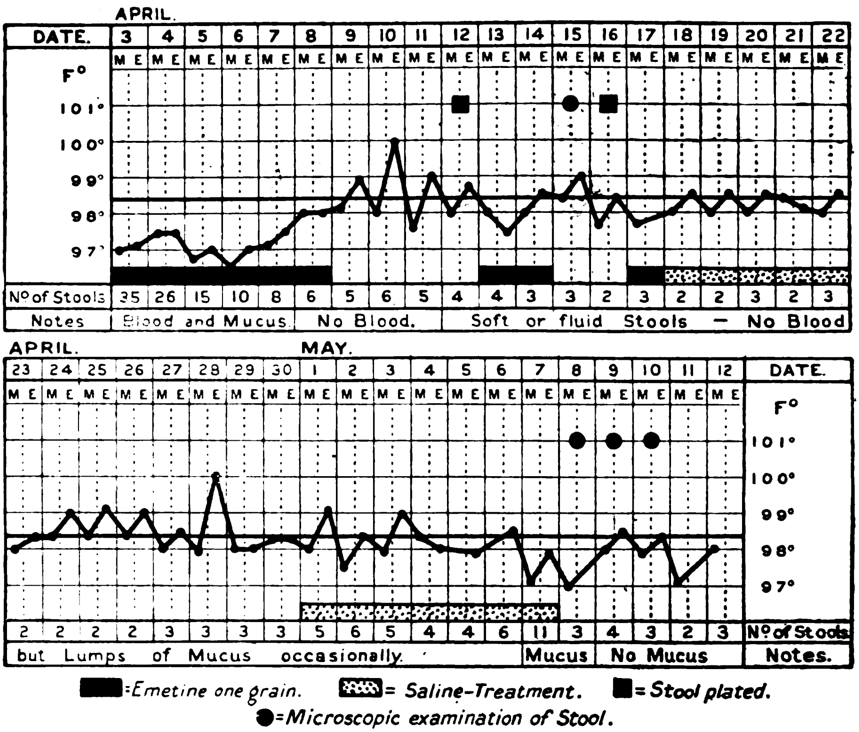


CHART 1.

Bacteriology.—Stools plated out April 12, 1916, and April 16, 1916. Result, a Gram-negative bacillus isolated with the following sugar reactions :—

	Glucose	Lactose	Dulcite	Saccharose	Mannite	Maltose	Indol
[1]	$\perp$	–	–	–	–	$\perp$	+

Non-motile and does not liquefy gelatine. It did not agglutinate with Shiga or Y serum. It was found to be virulent to animals (*vide infra*).

Blood Counts.—Five blood counts were taken, see chart. There was

[1] $\perp$ = acid, no gas ; + = acid and gas ; – = no change ; + in "Indol" column = indol produced from peptone.

a tendency to leucocytosis with excess of polymorphs. Mast cells were present, but scarce.

Treatment.—Emetine injections and dietetic.

Note.—Note the subnormal temperature during the severe stage at the commencement.

Case 2.—E. J., aged 21. (Shiga, variant type.)

History.—Diarrhœa for seven days prior to admission. No definite history of blood or slime in the stools. April 25, 1916: Tongue clean and moist. Pains in abdomen.

Examination of Stools.—April 25, 1916: Soft fluid stools with blood and mucus.

Case 2.—E. J. (Shiga, variant type).

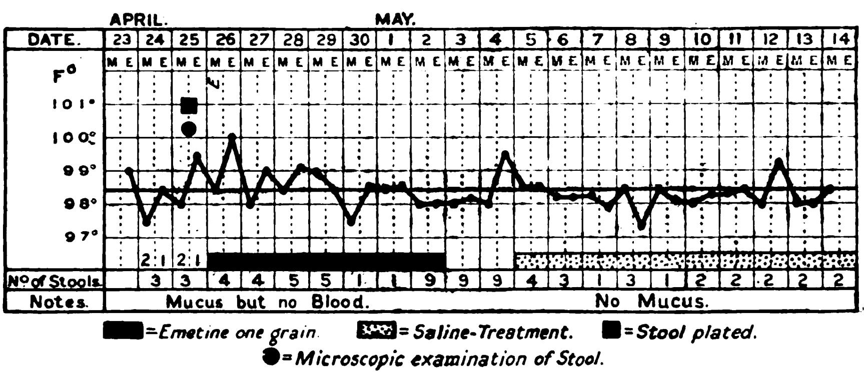


Chart 2.

Microscopic Examination.—Copious cellular exudate. Chiefly degenerate pus cells. No entamœbæ or other protozoa.

Bacteriology.—Stool plated out April 25, 1916. Result: A Gram-negative bacillus isolated with the following reactions:—

Glucose		Lactose		Dulcite		Saccharose		Mannite		Maltose		Indol
$\underline{\vert}$	..	−	..	−	..	−	..	−	..	−	..	+

Non-motile and does not liquefy gelatine. Does not agglutinate with Shiga or Y serum. Found to be extremely virulent to rabbits (*vide* p. 421). This organism differs from the classical type of *B. dysenteriæ* (Shiga), in that it produces indol. This type has been found frequently in other dysentery cases.

Treatment.—Emetine and saline. Diet: Arrowroot, Benger's food, beef tea, jellies, eggs. Gradual improvement.

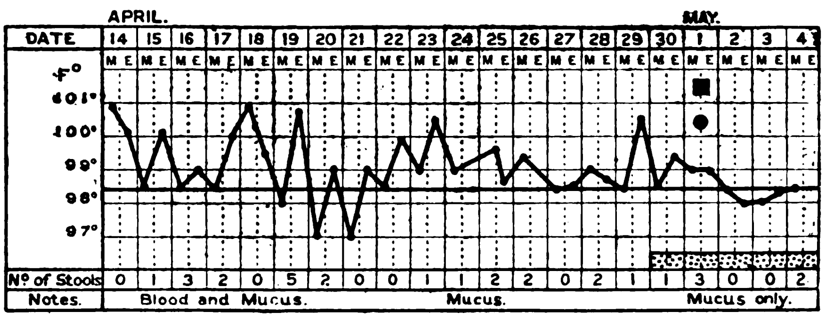
Case 3.—W. R., aged 19. (Shiga, variant type.)

History.—Illness commenced April 14, 1916. Admitted to hospital with headache, rigors, pains in limbs and abdomen and pyrexia. April 28, 1916: Complains of headache, dizziness, shivering and sweating at nights. Tongue furred.

Examination of Stools.—May 1, 1916: Fluid stools with mucus, but no blood.

Microscopic Examination.—Some cellular exudate, but not much. No protozoa.

CASE 3.—W. R. (Shiga, variant type).



= Saline-Treatment. ■ = Stool plated. ● = Microscopic examination of Stool.

CHART 3.

Bacteriology.—Gram-negative bacillus isolated with the following reactions.

Glucose	Lactose	Dulcite	Saccharose	Mannite	Maltose	Indol
$\underline{\mid}$	–	–	–	–	–	–

Non-motile and does not liquefy gelatine. Does not agglutinate with Shiga serum. Virulent to rabbits (*vide.* p. 421). Remained true to type. This organism has the cultural characters of *B. dysenteriæ* Shiga and is probably an inagglutinable variant of the classical type.

Treatment.—Diet as before. No emetine, but saline treatment.

(6) DETAILS OF TWO CASES OF DYSENTERY (FLEXNER Y TYPE), WITH CHARTS.

Case 4.—H. C., aged 23. (True Flexner Y type.)

History.—Diarrhœa commenced April 24, 1916. The stools contained a large amount of blood and mucus. Tongue raw, dry and cracked. Sores on the lips. Abdomen tumid and tender all over.

Examination of Stools.—April 27, 1916: Fluid stools with flakes of tissue, like mincemeat; blood and mucus.

Microscopic Examination.—No amœbæ or other protozoa could be found at any time. Numerous granular pus cells and large degenerated epithelial cells found, and also red cells.

Bacteriology.—Stools plated out April 27, 1916. Gram-negative bacillus isolated with the following sugar reactions:—

Glucose	Lactose	Dulcite	Saacchrose	Mannite	Maltose	Indol
$\underline{\mid}$	–	–	–	$\underline{\mid}$	$\underline{\mid}$	+

Non-motile and does not liquefy gelatine. It reacts to Y serum in the highest titre. This is a *B. dysenteriæ* of the Flexner Y group.

Blood Counts.—April 29, 1916: Leucocytes, 17,000 per cubic millimetre.

CASE 4.—H. C. (True Flexner Y tppe).

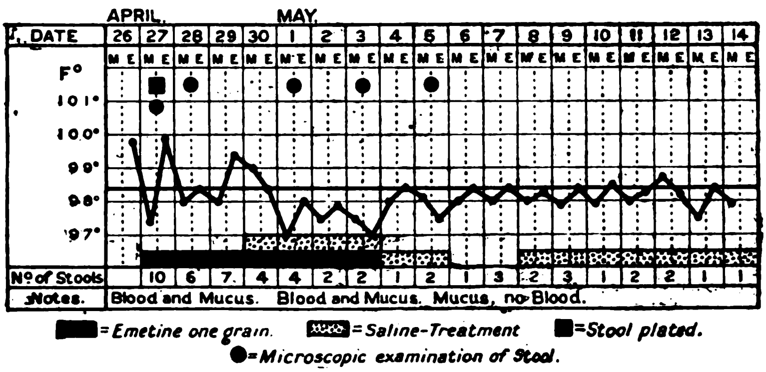


CHART 4.

Treatment.—As indicated on chart. Diet as before.

Notes.—This patient made a good recovery. Not allowed out of bed till after May 14, 1916.

Case 5.—T. T., aged 25. (True Flexner Y type.)

History.—Diarrhœa commenced April 23, 1916. Stools on admission consisted almost entirely of blood and mucus. Admitted in a very collapsed condition: tongue very coated; lips cracking; abdomen painful and tender all over; pulse weak and running.

CASE 5.—T. T. (True Flexner Y type).

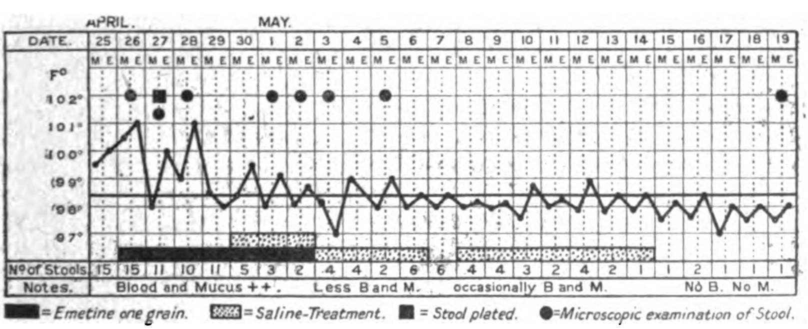


CHART 5.

Examination of Stools.—April 26, 1916: Watery stools with blood and mucus. April 28, 1916: Stools greyish in colour with excess of pussy mucus. May 17, 1916: Stools begin to be solid and formed.

Microscopic Examination.—No amœbæ or other protozoa could be found at any time. Copious cellular exudate consisting chiefly of highly granular polymorphic leucocytes, also numerous degenerating mononucleated cells. Also large highly vacuolated cells with included red cells and polymorphs. These latter cells were common in our dysentery cases. Their exact nature is not yet determined. They were non-motile. May 2, 1916 and onwards: No cellular exudate seen microscopically.

Bacteriology.—Stools plated out April 27, 1916. Gram-negative bacillus isolated, giving the following reactions:—

Glucose	Lactose	Dulcite	Saccharose	Mannite	Maltose	Indol
⊥	−	−	−	⊥	⊥	+

Non-motile and does not liquefy gelatine. Reacts to Y serum in the highest titre. This is a *B. dysenteriæ* of the Flexner Y group. The plate cultures also contained large numbers of colonies of *B. fæcalis alkaligenes.*

Blood Count.—April 29, 1916: Leucocytes 16,500 per cubic millimetre.

Treatment.—As on chart. Diet as before.

Notes.—Good but slow recovery. The emetine treatment had no effect on the pulse-rate.

(7) Details of Two Cases of Dysentery (Atypical Dysentery Bacilli, Mannite-fermenters).

Case 6.—F. J. H., aged 30. (Flexner Y bacillus, variant type.)

History.—Diarrhœa commenced on April 11, 1916, with blood and mucus.

Examination of Stools.—April 28, 1916: Some mucus, no blood. May 19, 1916: Still small masses of mucus.

Microscopic Examination.—No amœbæ or other protozoa found at any time. Some cellular exudate present in the mucus.

Bacteriology.—Stools plated out April 28, 1916. Gram-negative bacillus isolated with the following reactions:—

Glucose	Lactose	Dulcite	Saccharose	Mannite	Maltose	Indol
⊥	−	−	−	⊥	⊥	+

Non-motile and does not liquefy gelatine. Did not react to Shiga or Y serum. Found to be virulent to rabbits (*vide infra*). It mutated in artificial cultures and developed the power of fermenting lactose. The original strain has the cultural characters of *B. dysenteriæ* Flexner Y group. It is probably a variant of the classical Flexner Y type. *B. fæcalis alkaligenes* was also present.

Treatment.—As on chart. Diet as before.

Notes.—This chronic type of case with the passage of a few semi-solid stools daily, with little masses of viscid mucus and no blood, was very common.

CASE 6.—F. J. H. (Flexner Y, variant type).

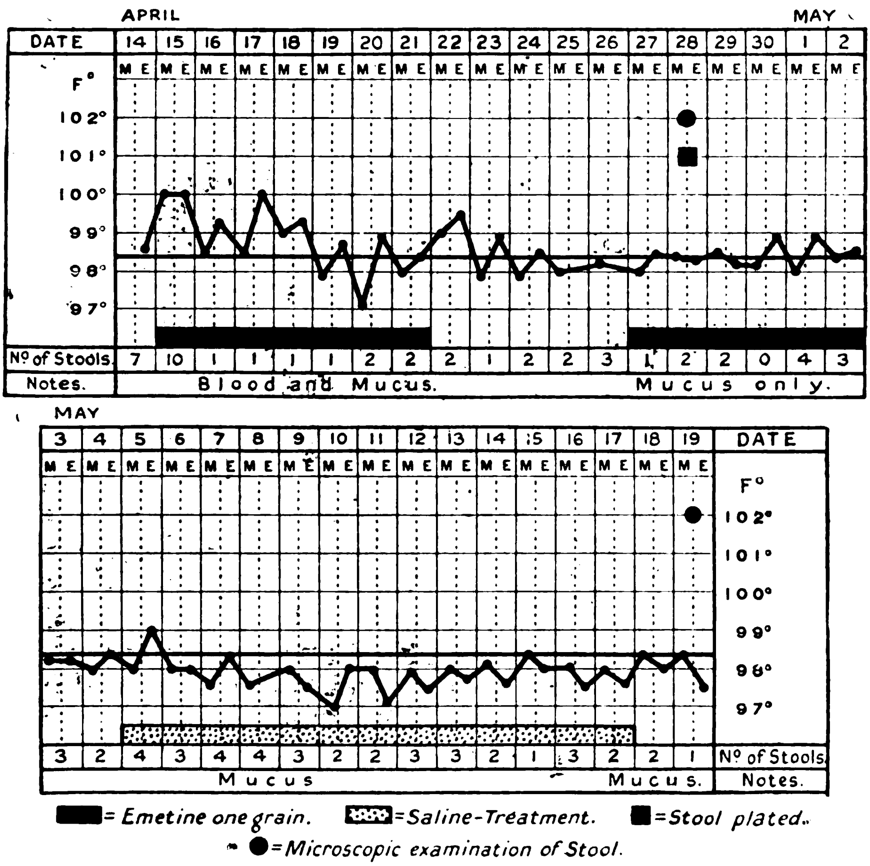


CHART 6.

Case 7.—C. P., aged 20. (Flexner Y bacillus, variant type.)

History.—Admitted into hospital April 9, 1916, with blood and mucus in stools. Pains in abdomen and tongue coated. From April 9, 1916, till April 17, 1916, he was in No. 17 Stationary Hospital. We have no record of his temperature during that time. He was thought to be suffering from amœbic dysentery. April 17, 1916: No pains in abdomen now. Tongue clean.

Examination of Stools.—Some clear mucus, but no blood.

Microscopic Examination.—No amœbæ or other protozoa found. Columnar epithelial cells numerous, also some pus cells.

Bacteriology.—Stool plated April 29, 1916. Gram-negative bacillus isolated with the following sugar reactions :—

Glucose		Lactose		Dulcite		Saccharose		Mannite		Maltose		Indol
⊥	..	−	..	−	..	−	..	⊥	..	⊥	..	+

CASE 7.—C. P. (Flexner Y, variant type).

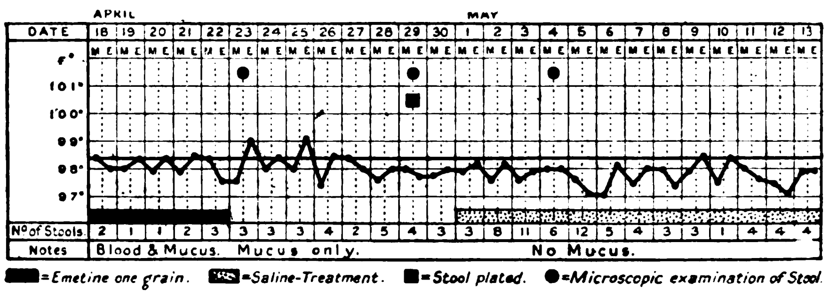


CHART 7.

Non-motile and does not liquefy gelatine. Does not react to Shiga and Y serum. Found to be virulent to rabbits. Mutated in artificial cultures and developed the power of fermenting dulcite and saccharose. The original strain has the cultural characters of *B. dysenteriæ* Flexner Y group. It is a variant species of the classical type. Considerable numbers of streptococci colonies were also found on the plate culture.

Treatment.—As on chart. Diet as before.

(8) DETAILS OF TWO CASES OF DYSENTERY (*Entamœba histolytica*).

Case 8.—J. H., aged 18. (*E. histolytica.*)

History.—Diarrhœa started April 11, 1916, with blood and mucus. Pains in abdomen and tenesmus.

Examination of Stools.—April 14, 1916: Fluid stools with blood and mucus flakes. April 18, 1916: Still blood and mucus. April 27, 1916: Still fluid stools with mucus, but no blood. May 19, 1916: Soft stools with neither blood nor mucus.

Microscopic Examination.—April 14, 1916. *E. histolytica* found. Also exudate of polymorph leucocytes and numerous red cells. April 16, 1916: Ditto. April 18, 1916: Ditto. April 27, 1916: No entamœba present, but still some cellular exudate. May 19, 1916: No protozoa and no cellular exudate.

Bacteriology.—Stools plated April 16, 1916, and April 27, 1916. Gram-negative bacillus isolated on both occasions with the following reactions :—

Glucose		Lactose		Dulcite		Saccharose		Mannite		Maltose		Indol
+	..	−	..	+	..	−	..	+	..	+	..	+

Non-motile and does not liquefy gelatine. This is not a true dysentery organism. *B. fæcalis alkaligenes* was also isolated.

Treatment.—As on chart. Diet as before.

CASE 8.—J. H. (*E. histolytica*).

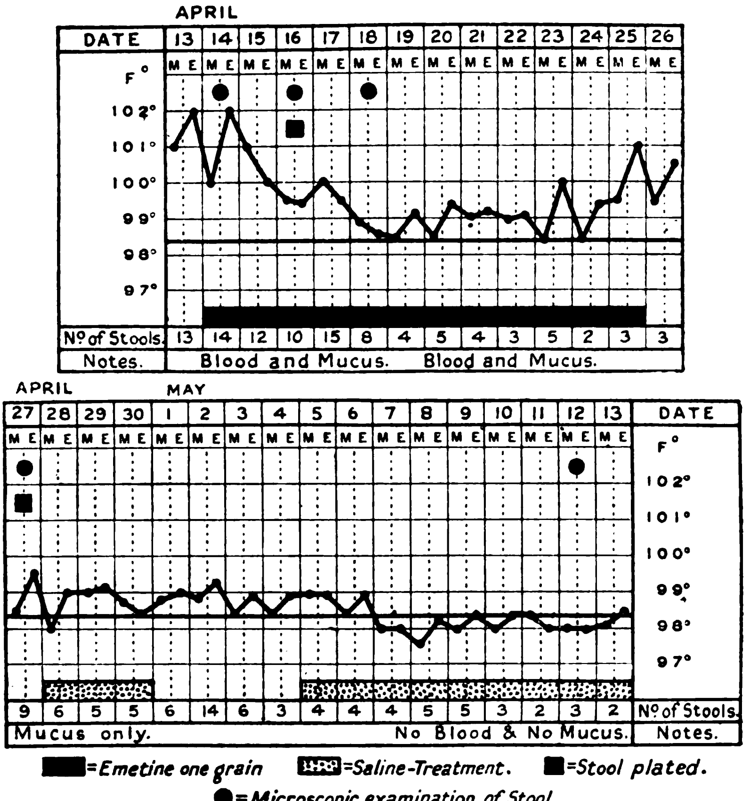


CHART 8.

CASE 9.—V. S. (*E. histolytica*).

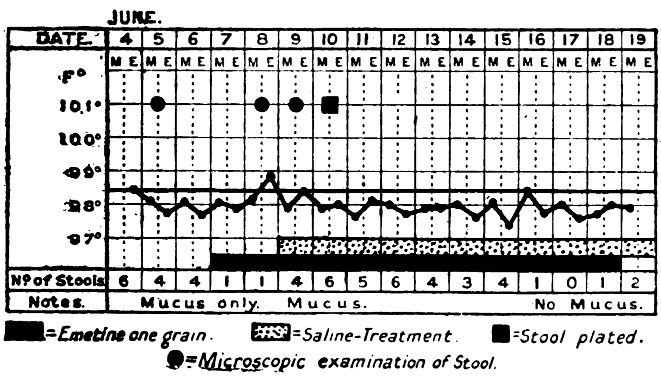


CHART 9

Case 9.—V. S., aged 20. (*E. histolytica.*)

History.—Illness commenced seven weeks ago, about April 18, 1916. He passed blood and mucus. Treated in the Victoria Hospital, Bombay, for five weeks, where he had eight injections of emetine. Had about six motions daily previous to admission to this hospital in Alexandria. Some tenderness on palpation over lower part of abdomen.

Examination of Stools.—Semi-solid stools containing flakes of mucus, but no blood.

Microscopic Examination.—June 5, 1916: Numerous motile *E. histolytica* and also cysts found, also *Tetramitus mesnili* flagellates present. Very little cellular exudate. June 8, 1916: Unable to find entamœba or cysts. June 9, 1916: A few entamœba cysts found, also a few tetramitus flagellates.

Bacteriology.—Stool plated June 10, 1916. A considerable number of colonies of *B. fæcalis alkaligenes* found, but no true dysentery bacilli.

Treatment.—Emetine and salines. Diet as before.

Case 10.—R. B. (*B. Morgan* No. 1).

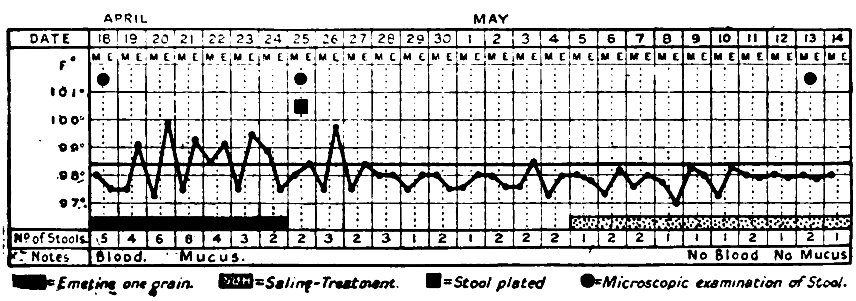


Chart 10.

(9) Details of one Case of Dysentery (*B. Morgan*, No. 1).

Case 10.—R. B., aged 20. (*B. Morgan* No. 1.)

History.—Diarrhœa commenced on April 3, 1916. Passed blood and slime. Had five grains of emetine injected before admission to this hospital on April 18, 1916. No pain in abdomen or elsewhere. Tongue raw.

Examination of Stools.—Very liquid at first, with a large amount of mucus and some streaks of blood. Later, May 13, 1916: Soft semi-solid stools with no blood or mucus.

Microscopic Examination.—April 18, 1916: No entamœba or other protozoa found. Pus cells and epithelial cells numerous. April 13, 1916: No blood and no cellular exudate present.

Bacteriology.—Stool plated on April 25, 1916. Large numbers of

colonies of a Gram-negative bacillus were present with the following sugar reactions :—

Glucose	Lactose	Dulcite	Sacchaiose	Mannite	Maltose	Indol
+	−	−	−	−	−	+

Motile, and does not liquefy gelatine. It is a typical *B. Morgan*, No. 1.

(10) Details of One Case of Dysentery (*Bacillus fæcalis alkaligenes*).

Case 11.—H. K., aged 30. (*Bacillus fæcalis alkaligenes.*)

History.—Patient became ill with diarrhœa March 15, 1916. Had blood and mucus in his stools. Temperature at time of reporting sick 103° F. Has had two and a half grains of emetine. Tongue flabby with fine fur. Abodmen tender on right side.

Case 11.—H. K. (*B. fæcalis alkaligenes*).

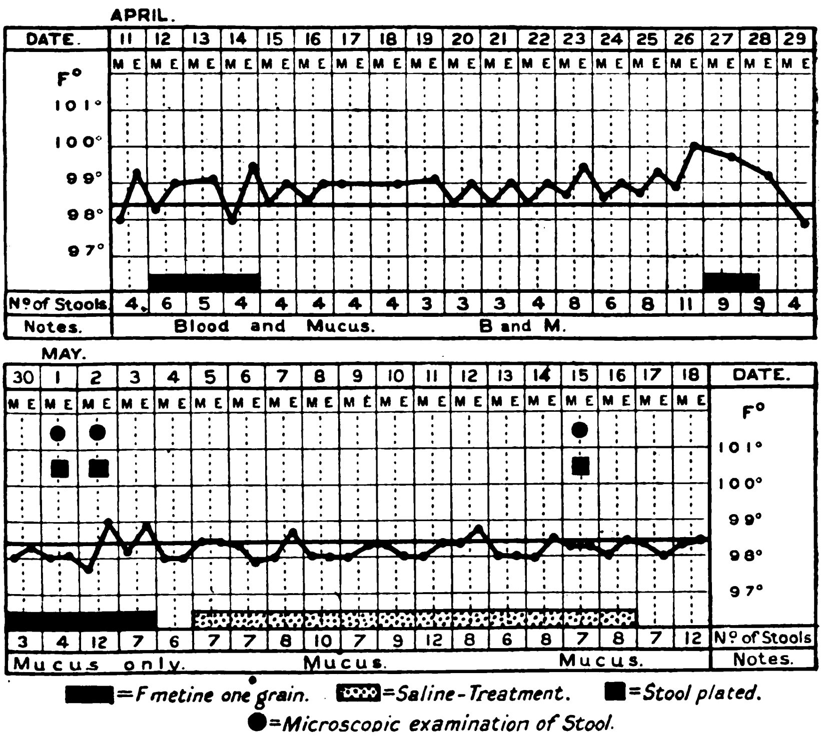


Chart 11.

Examination of Stools.—At first, fluid stools with blood and mucus. May 1, 1916, semi-solid stools, small masses of mucus only.

Microscopic Examination.—No entamœba or other protozoa found. Some cellular exudate, chiefly degenerate pus cells.

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Bacteriology.—Stools plated May 1, 1916, May 2, 1916, and May 15, 1916. The only organism isolated was *B. fæcalis alkaligenes* (present in large numbers).

Notes.—This is a case of chronic dysentery in which no true dysentery organisms could be found.

CASE 12.—D. B. (STREPTOCOCCI).

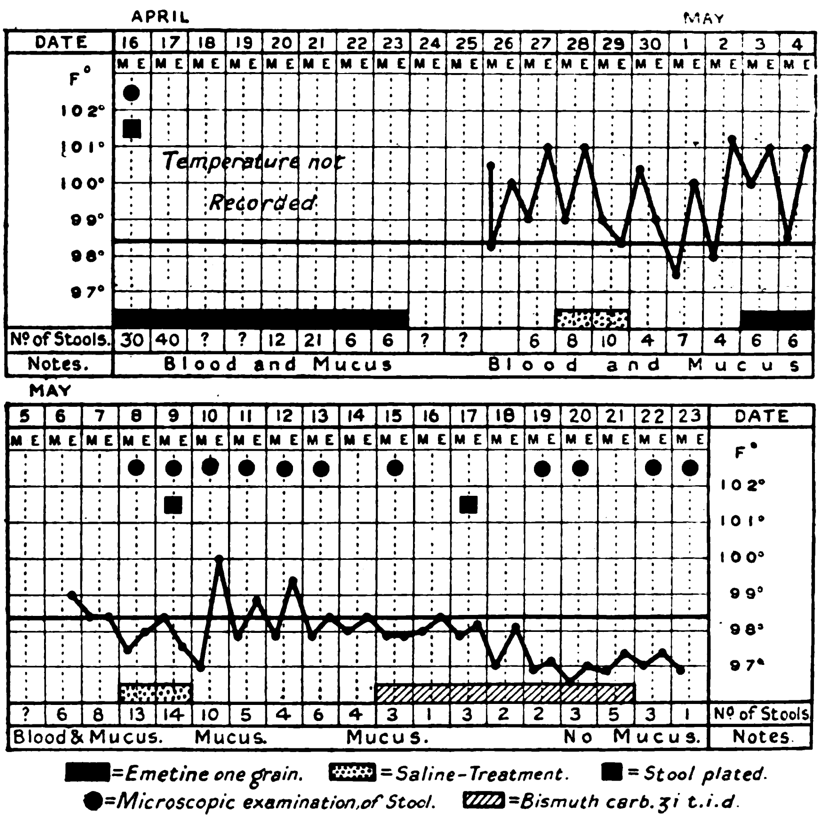

CHART 12.

11) DETAILS OF ONE CASE OF DYSENTERY (ONLY STREPTOCOCCI FOUND).

Case 12.—D. B., aged 18. (Streptococcus.)

History.—The patient commenced to have diarrhœa on April 11, 1916. Admitted into the 31st General Hospital, Port Said, on April 13, 1916, with severe diarrhœa with blood and mucus. He had thirty to forty motions daily. Transferred to our hospital, Alexandria, May 5, 1916.

Clinical Notes.—The patient looks very flushed and worn out. Lips dry, tongue furred, pulse feeble. Bed-pan used about every ten minutes.

Much tenesmus. Abdomen very tender to touch. Descending colon palpable. No record of temperature up to April 26, 1916. Treatment received in 31st General Hospital: emetine 8 grains as on chart, also 80 cubic centimetres of anti-dysenteric serum injected.

Examination of Stools.—May 8, 1916: Fluid stools with mucus and no blood. May 9, 1916: Greyish fluid mucous stools; ditto until May 19, 1916. Stools after May 19, 1916, are semi-solid with no mucus.

Microscopic Examination.—May 8, 1916: Copious cellular exudate, chiefly granular polymorphs, also large vacuolated round cells with crescentic chromatin. No entamœbæ or other protozoa present. All other examination negative for protozoa.

Bacteriology.—In No. 31 General Hospital the stools were examined microscopically and plated out for bacilli. No entamœbæ were found and no Shiga or Flexner bacilli were isolated. Patient was admitted to our hospital on May 6, 1916 in a very weak condition. Stools plated by us as indicated on the chart. No noteworthy organisms were isolated, but the plates showed a great preponderance of streptococci, also some colonies of *B. fæcalis alkaligenes*.

Blood Counts.—May 8, 1916: Leucocytes, 20,000 per cubic millimetre. May 9, 1916: 25,000 per cubic millimetre.

Notes.—This case commenced so acutely that one would have expected to find a Shiga type of bacillus, yet at no time were any dysentery organisms isolated. Patient eventually made a good recovery about June 18, 1916.

(12) The Pathological Effects produced in Rabbits by the Atpyical Strains of Dysentery Bacilli obtained by us.

We have given in detail some cases of dysentery in which the organisms isolated have the cultural characters of known dysentery bacilli, but which do not react to the anti-sera of the classical types and some of these mutated in artificial culture by ultimately exhibiting different sugar reactions. These organisms have proved to be as pathogenic to animals on intraperitoneal injection as the classical types. The injection of living cultures, intraperitoneally, of these atypical strains produced death in rabbits and guinea-pigs after eight to twenty-four hours. On post-mortem examination the greater part of the small intestine was found to contain little or no fæcal matter. The contained material was very largely an opaque, bile-stained, often sanguineous mucus laden with considerable masses of desquamated mucosal cells. Shedding of the epithelium in particular was observed to be a very diffuse and early phenomenon and there was intense inflammation of the

whole mucosa. A noted naked-eye feature in some cases was the presence of numerous superficial, but distinctly submucous petechial hæmorrhages or even larger effusions. The striking resemblance of these appearances in the intestines of experimental animals to those found in the small intestine of infants dying as a result of acute entero-colitis was noted by Major Ferguson. The cellular exudate in our experimental animals consisted chiefly of mononucleated types of cells—desquamated epithelium, etc. Polymorphic pus cells were not abundant. In the human cases on the other hand the cellular exudate was largely polymorphic. Of course we must remember that the experimental animals died so quickly that there was no time for ulcers to form or for a polymorphic exudate to occur in consequence. These effects on the rabbits and guinea-pigs were produced by the injection of as little as one-tenth of a twenty-four hour agar slope culture of the organism, and the same effects were produced by intravenous injection as by intraperitoneal injection.

(13) Further Remarks.

We have given some details of twelve cases and have published the charts, so as to give an idea of the types of dysentery coming into hospital in Egypt in the spring of 1916. On examining the charts, it will be seen that no one could dare to diagnose the causal agent from the temperature, nor even from the severity of the symptoms. Nor does there seem to be any hope of diagnosing the type of dysentery from the microscopic appearance and number of the stools. Our investigation, indeed, would seem to hold forth little hope of diagnosing the type of dysentery clinically. This apparently can only be ascertained by careful microscopic examination of the stools for entamœbæ or other protozoa and at the same time by careful and skilled bacteriological work in attempting to isolate the various types of bacilli. No doubt many epidemics of dysentery in various parts of the world have been due chiefly to one definite organism, such as the Shiga or Flexner bacillus. The Gallipoli epidemic, however, was not so uniform. At first it was largely the amœbic type of dysentery; later on in Egypt we have found that every possible variety was present and many of these were undoubtedly mixed cases. There can be no doubt that in Egypt every kind of dysentery is endemic. Dysentery occurs there at all seasons of the year, but the incidence becomes much higher during the hotter weather.

(14) Conclusions regarding the Treatment of Dysentery Cases.

We do not wish to go fully into the treatment here, but only to bring out a few points which seem to be of importance. It is highly important to treat patients showing dysenteric symptoms thoroughly and at once. We have shown that it is almost impossible to diagnose the type of dysentery clinically. A laboratory may not always be at hand, and in any case it takes about three days to tell in the laboratory which definite dysentery bacillus is the cause. It will be noted from our charts that nearly every case was treated as soon as admitted to hospital with injections of emetine, on the supposition that it might be amœbic dysentery. Saline treatment was not adopted so quickly, as at that time the clinicians in our hospitals believed that the majority of cases were amœbic, and their belief in this was supported by the results obtained from giving this drug. In many cases the administration of emetine was followed by a marked clinical improvement in spite of the fact that many of such cases were bacillary types. No bad effects resulted from emetine in this hospital out of some thousands of cases. Many received as much as 12 to 18 grains continuous treatment of 1 grain daily, and nearly all received at least 8 grains. In our opinion it is not bad practice to administer emetine, even although no *E. histolytica* are found, and even although true dysentery bacilli have been isolated. Dr. Bartlett has shown in post-mortem sections numerous *E. histolytica* in cases where none were found in the fæces during life. In any case, considering the beneficial effect of emetine noted by many observers on even bacillary cases, we advocate that all cases of dysentery should be treated at once by both emetine injections and by salines; meanwhile the stools can be sent to the laboratory for examination. If after some three or four days it is definitely proved that no entamœbæ are present, and that the case is truly bacillary, then it is time enough to stop the emetine and to continue with the saline treatment alone. In very severe cases, and in fact in all cases, a considerable dose (some eighty cubic centimetres) of anti-dysenteric serum should be injected at once, and if this is followed by a marked clinical improvement this dose should be repeated next day. If all cases were treated early in this fashion, we feel convinced that there would be fewer cases of chronic dysentery, since untreated or improperly treated cases usually exhibit chronic symptoms for many months, and many as a result have bowel troubles all their lives. On our charts we

have shown graphically the days on which saline treatment was given without indicating the details of that treatment. As a rule, one to two drams of sodium sulphate were given, at first two-hourly until the motions became more clear and less grey and purulent, later one dram was given four-hourly and later reduced to six-hourly doses. If on stopping the saline treatment the patient becomes constipated then give salines again. No definite dosage can be laid down. The object is to clear away the bacilli and the toxins and also to rid the bowel of the pussy exudate. The amount given should be regulated by the results obtained. In purely amœbic cases, on the other hand, one should give salines for this same reason as well as the emetine injections. To return once again to our charts, the cases in our opinion which were most perfectly treated were Case H. C., Chart 4; Case T. T., Chart 5; and Case V. S., Chart 9. The results in these cases, it will be noted, were very quick and satisfactory. The treatment would have been still more perfect and thorough if both the emetine and saline had been started on the first day of admission and if anti-dysenteric serum had been given as well. A new suggestion with regard to further specific treatment is given in the *Tropical Diseases Bulletin*, vol. viii., No. 5, pp. 300, October, 1916. Dr. Fraser, the Director of the Kuala Lumpur Laboratory, Malaya, regards the use of vaccines as likely to give the best results in bacillary dysentery and states that apart from the value of vaccines as a curative agent the treatment will confer a higher degree of immunity than that which may be derived from an unaided recovery, and that the tendency to relapses, or recurrences, will be lessened.

The diet is very important in dysentery. The cases which we investigated were given during the acuter stages—"no diet"—consisting of beef tea, bovril, jelly, whey, junket, albumen water and Benger's food. If there was marked improvement, then in about ten days this diet was increased to "milk diet" consisting of the above with the addition of tea, custard, six biscuits per day, two boiled eggs and a little bread and butter. As the improvement gradually increases the diet becomes more liberal.

The sheet-anchor treatments of dysentery therefore are emetine, salines and diet. The anti-serum and vaccine treatments are still[1]

[1] We also consider that bismuth salts in large doses are not to be forgotten; we think that this treatment, adopted by Deeks and James in Panama, has not been given a sufficient trial by British workers. It should certainly be tried in cases which do not yield to emetine and saline treatment.

in the experimental stage, and may perhaps be of great value when more thoroughly worked out. At present the anti-serum supplied is not polyvalent enough, since, as we have pointed out, many strains of dysentery bacilli were isolated which did not react to Shiga or Flexner agglutinating sera.

(15) Some Remarks on Sanitation and the Prevention of Dysentery.

It is almost impossible to emphasize too much the crying need for preventative measures. Physicians are apt to become so bouud up with the diagnosis and treatment of diseases that they neglect prevention, which is better than cure. Dysentery in all its forms, amœbic and bacillary, is transmitted principally by flies and water. In Egypt, more especially in the larger towns, where the water supply is fairly good, it is undoubtedly the house-fly which carries the organisms from exposed fæcal deposits to the food. The measures necessary to prevent and stamp out these diseases have already been given in some detail, *vide* Thomson, D., and Thomson, J. G. (Journal of the Royal Army Medical Corps, July, 1916). We will again enumerate the essentials required.

(1) A pure water supply well guarded from contamination.

(2) A pure milk supply, and failing that, the boiling of all milk before consumption.

(3) A thorough disposal of fæcal matter in such a way that flies can have no opportunity of alighting upon it.

(4) The destruction of the breeding-places of flies—refuse and dung heaps.

(5) The thorough fly-screening of all mess-rooms, food stores and kitchens.

(6) The isolation and thorough treatment of all cases of dysentery in fly-screened hospital wards.

The faults in Alexandria were especially mentioned because the authors had lived for a year in that town. We wish to again repeat the reforms which we consider necessary in Alexandria, in the hope that they may be quickly carried out.

(1) A considerable number of public latrines must be erected, and thereafter all natives found using open spaces and the foreshore as places for defæcation must be severely punished.

(2) The yards and premises of native houses all over the town must be cleaned up, since very many of them are breeding flies and many contain in addition exposed human fæcal matter.

(3) A proper system of sanitation must be developed, dividing the town into districts with trained sanitary inspectors for each.

(4) The "Capitulations" system must be abolished or modified in such a way as to allow sanitary by-laws to be passed, in order to enable sanitary officers and inspectors to enter and examine yards and premises and to report on their condition. If these premises are filthy and are breeding flies, then the by-laws should be such as to make this nuisance a punishable offence unless remedied by the occupant of the premises within a certain time. Until this is done dysentery and typhoid fever in all its forms will remain endemic in Egypt, and the Egyptian towns must be considered as insanitary and unhealthy for tourists and troops living in and around them. The world is progressing and Egypt must progress in these matters. It is important that such progress should commence at once, since the health of our troops now protecting its borders and its towns is so important. After the War, Egypt will become again a great resort for travellers and tourists. With its incomparable winter climate, it will remain a health resort — a health resort indeed, but there will always be the risk of disease so long as the measures indicated above are not carried out. But of far greater advantage would these reforms be to the Egyptians themselves. The infantile mortality in Egypt is extremely high, because of these fly-borne intestinal diseases; and not only do the Egyptian children suffer, but the adults as well. Lieutenant-Colonel Wenyon estimated that some twenty per cent of the natives were carriers of amœbic dysentery. Our army camps are remarkably well-kept and clean; but, unfortunately, that is not sufficient. The dangers of flies and the dangers of the proximity of the camps to insanitary native quarters have not been fully realized, and in consequence these highly important dangers have not yet been abolished. Two great reforms are necessary:—

(1) The thorough fly-screening of mess-rooms, kitchens, and canteens in all permanent camps and hospitals.

(2) The removal of camps to some miles distance from insanitary native areas, since owing to lack of sanitary by-laws it is not possible so far to clean up such areas. The Army engineers, busy in the midst of other important duties, are apt to think that fly-screening is a very minor and unimportant piece of work which can wait. But that is wrong. It is a small piece of work, but it is of the very highest importance. A new system is required, copying so far as is possible the organization adopted by the American Army on the Panama Canal zone, where there existed a

definite sanitary organization, with a special body of sanitary engineers. Thus our Army requires, in addition to the Royal Army Medical Corps Service, a special and distinct sanitary service, containing its own sanitary engineers. It has become quite obvious to expert sanitarians that only by some such reform and system will the sanitary measures so important and necessary be quickly and thoroughly enough carried out to be of use. Such a system would save many epidemics and much money now spent on hospitals, hospital ships, sickness and disease.

A BACTERIOLOGICAL EXAMINATION OF CONVALESCENTS FROM THE MEDITERRANEAN EXPEDITIONARY FORCE.

FROM THE PATHOLOGICAL LABORATORY OF THE UNIVERSITY OF MANCHESTER.

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(*Report to Medical Research Committee.*)

ALL the material on which this report is based was obtained from 488 men invalided from the Mediterranean Expeditionary Force for enteric fever or dysentery. The majority of cases came from the Gallipoli Peninsula. These 488 patients, forming a portion of the large number of enteric and dysentery convalescents admitted to the 2nd Western General Hospital, were sent to the Hope Auxiliary Military Hospital. Almost all the cases were convalescent and very few exhibited any signs of intestinal trouble.

In the majority of cases the regulation examinations of the fæces and urine were carried out; that is to say—six bacteriological examinations of fæces and urine for enteric, and three bacteriological and three protozoological examinations for dysentery patients. Some of the patients were removed from Hope Hospital before the full number of examinations had been completed. The results of our examinations showed that the bacteriological finding did not in every case agree with the original diagnosis. Acting on this result we undertook a microscopical examination of fæces from 259 cases of enteric convalescents. In seven of these cases the *Entamœba histolytica* was discovered. The sera of 317 cases were examined for agglutinins against *Bacillus typhosus*, *B. paratyphosus* A, *B. paratyphosus* B, and *B. dysenteriæ* (Shiga). We were only able to examine 190 of the sera against *B. dysenteriæ* Y, as we had great difficulty in obtaining a strain of this bacillus which was satisfactory for the purpose.

METHODS.

Bacteria.—Both fæces and urine were plated on MacConkey's neutral red lactose bile salt agar medium. Subcultures were given a preliminary examination by testing their reactions in broth, litmus milk and cane sugar, glucose, lactose, and mannite peptone

water. The broth culture was examined after twenty-four hours for motility and after five days for the presence of indol. Strains which corresponded in this limited series of reactions with those of the known pathogenic species were tested by the agglutination reaction. In these tests an emulsion of a stock strain of the homologous bacillus was invariably employed as a control.

Agglutination.—The macroscopic method was employed. In the majority of cases the blood was obtained from an arm vein. The serum was separated after twenty-four hours. The dilutions were made with graduated pipettes. Each serum dilution was made up to a bulk of one cubic centimetre. To each cubic centimetre of diluted serum there was added one cubic centimetre of bacterial emulsion. The tubes were left at room temperature and the results were read after twenty-four hours. The degree of agglutination was judged by the naked eye. The bacterial emulsions were prepared by rubbing up twenty-four hour cultures of stock strains in saline solution. The stock emulsions were treated with formalin. The stock strains of typhoid and paratyphoid A and B were laboratory cultures which have been used by one of us for many years for serum work. The culture of Y bacillus was sent to us by Dr. W. J. Penfold, that of the Shiga bacillus by Miss Chick of the Lister Institute. All these strains were very carefully tested. This is a matter of some importance as some strains of paratyphoid and dysentery bacilli are readily agglutinated by normal sera in low dilution (1 in 25 to 1 in 100), although the control tube which contains the emulsion without serum may show no trace of agglutination. From these strains we prepared antisera by the intravenous inoculation of rabbits. Stock dilutions of antiserum in saline solution containing 0·5 per cent carbolic acid as recommended by Ledingham and Penfold (1915) were found to effect a considerable economy.

B. PARATYPHOSUS A.

These strains fermented glucose and mannite but had no action on cane sugar and lactose. Gas formation on glucose and mannite was slow and amounted to no more than a small bubble after seven days. The bacilli were motile and did not produce indol. On litmus milk slight acidity was noted. The strains were agglutinated by a known antiserum to the limit of its titre. Strains which satisfied the above tests were isolated from 3 of the 488 cases, in 2 cases from the fæces, in 1 from the urine. Of

these cases two had been diagnosed as enteric fever and one as dysentery.

One case was examined 3 times with 3 positive results; one case was examined 7 times with 3 positive results; and one case was examined 7 times with 1 positive result. Serum was examined from these cases with the following results: One serum agglutinated a paratyphoid A emulsion in a dilution of 1 in 100, the other two in dilutions of 1 in 200 and 1 in 400 respectively.

B. PARATYPHOSUS B.

These strains fermented glucose and mannite but had no action on cane sugar and lactose. In contradistinction to the strains of *B. paratyphosus* A, gas formation was well marked on glucose and mannite.

The bacilli were motile and did not produce indol. On litmus milk slight acidity was produced which was followed by the development of an alkaline reaction in two cases on the third day, and one on the eighth day. The strains were agglutinated by a known antiserum to the limit of its titre.

Strains which satisfied the above tests were isolated from three of the 488 cases, in each case from the fæces, and each case had been diagnosed as enteric fever.

One case was examined 4 times with 4 positive results; one case was examined 6 times with 2 positive results; and one case was examined 4 times with 1 positive result.

Serum was examined from these cases with the following results: One serum agglutinated *B. paratyphosus* B in dilution of 1 in 1,600, the other two in dilutions of 1 in 800 and 1 in 400 respectively.

B. DYSENTERIÆ (FLEXNER) AND B. DYSENTERIÆ Y (HISS AND RUSSELL).

Two strains gave the reactions of the typical Flexner bacillus. These strains were non-motile, produced acid but not gas in glucose, maltose and mannite, produced indol and were agglutinated by a known anti-Flexner serum. The serum of neither patient agglutinated a stock *B. dysenteriæ* Y in a dilution of 1 in 50.

The results obtained by the examination of one of these patients were sufficiently remarkable to justify separate mention.

This man (G.) was taken ill on December 21, at Suvla Bay (he had previously been at Lemnos). He had had two inoculations

of typhoid vaccine, in May and June, 1915. He was diagnosed as enteric fever. He was four weeks at the 19th Stationary Hospital at Imbros and five weeks at the 21st General Hospital at Alexandria.

At the time of examination April to July, 1916, he was quite convalescent, there was no diarrhœa. The fæces were examined on seven occasions. The MacConkey plates were usually covered with pale colonies.

The results of the examinations were as follows:—

Examination	Result
April 3	Flexner bacillus
,, 18	No pathogenic bacteria
,, 26	Y bacillus
May 11	Y bacillus
,, 31	Y bacillus and Flexner bacillus
June 1	Y bacillus
,, 21	Y bacillus

The fæces of this patient were found to contain two strains of dysentery bacilli, the one of which fermented maltose, while the other strain did not. The agglutination reactions of the patient's serum in a dilution of 1 in 50 were as follows:—

Typhoid	Paratyphoid A	Paratyphoid B	Y bacillus	Shiga bacillus
++++	0	++++	+++	0

On further examination the serum agglutinated paratyphoid B in a dilution of 1 in 1,000, and bacillus Y in a dilution of 1 in 100. The serum also agglutinated the Y strain isolated from the patient, but not the Flexner strain isolated from the patient.

From another case a strain was isolated which gave the cultural reactions of a Flexner bacillus but was not agglutinated by the stock antiserum. The serum of this patient was unfortunately not examined. Two strains gave the cultural reactions of the Y bacillus but were not agglutinated by the stock antiserum. The sera of these two patients were examined. One agglutinated the stock strain of Y bacillus in a dilution of 1 in 400, the other failed to produce agglutination in a dilution of 1 in 50.

The result may be summarized as follows:—

The fæces were examined from 488 cases and the Flexner bacillus was isolated from two cases and the Y bacillus from two cases. From one case both the Flexner and the Y type were isolated.

B. DYSENTERIÆ (SHIGA).

This micro-organism grows somewhat slowly on MacConkey plates, and the colonies at the end of the first twenty-four hours

are smaller than those of *B. typhosus*. The strains isolated fermented glucose but had no action on cane sugar, lactose and mannite. They were non-motile and did not produce indol. On litmus milk slight acidity was produced after twenty-four hours. The acidity usually disappeared after three to seven days. The strains were agglutinated by a known antiserum to the limit of its titre.

The bacillus was isolated from the fæces of six of the 488 cases. Of the six patients 2 had been diagnosed as dysentery, 3 as enteric fever, and 1 as dysentery and enteric. One case was examined 3 times with 2 positive results; one case was examined 7 times with 4 positive results; one case was examined 4 times with 1 positive result; one case was examined 3 times with 1 positive result; two cases were examined 6 times with 1 positive result. Serum was obtained from each of these six cases and three completely agglutinated an emulsion of Shiga bacilli in a dilution of 1 in 50, and three failed to produce agglutination. Of these three sera, one had a titre of 1 in 400 and two of 1 in 200.

Other Strains Isolated.

The following account gives some details of various strains isolated from the fæces which produced pale colonies on the MacConkey plates.

Paratyphoid Group.

A large number of strains were isolated which presented cultural characteristics resembling those of the known paratyphoid bacilli.

Strains which Produced Indol.

These micro-organisms fermented glucose and mannite and did not ferment lactose and cane sugar. They produced indol. The majority produced much more gas than paratyphoid B in glucose and mannite, but two strains produced no gas in mannite and one no gas in glucose. None of these strains liquefied gelatine. Strains presenting these general characteristics were isolated from seventy-seven patients. In one case a strain of this type was isolated on three occasions from the fæces of the same patient, on six occasions twice, in the majority of occasions only once. These strains can be divided into three groups according to their action on litmus milk.

Group A.—Thirteen strains produced no permanent change on litmus milk. In three cases slight acidity which subsequently disappeared was observed after twenty-four hours incubation.

Group B.—Ten strains produced definite permanent acidity. In four cases a clot was formed.

Group C.—Fifty-four strains produced a definite alkaline reaction. Of these nine showed an acid reaction at the end of twenty-four hours.

Of these 77 strains 9 were submitted to an agglutination test with the patients' serum. Of these 9 strains 4 showed slight agglutination with the patients' serum in dilutions of 1 in 25 and 1 in 50. In no case was agglutination complete even in a dilution of 1 in 25 of serum, and we are not inclined to attach any significance to the results obtained. Bacilli which resemble in cultural characteristics the paratyphoid bacilli except that they produce indol, occur in normal fæces, and are well known to all bacteriologists.

Strains which did not produce Indol.

Strains closely resembling Paratyphoid A.

Four strains will be considered under this heading.

(1) This strain was isolated from a soldier (M.) who was taken ill on October 28, 1915, at Cape Helles, where he had been stationed after June 13. The illness was diagnosed as enteric fever and lasted six weeks. He was removed to a hospital in Malta. He had had two doses of typhoid vaccine. At the time of the bacteriological examination he was in perfectly good health and condition. At the first examination a few pale colonies were observed on the MacConkey plates. The strain isolated was a Gram negative, non-motile bacillus resembling in its morphology and cultural characteristics on agar the members of the *B. coli—B. typhosus* group. The bacillus fermented glucose and mannite but not lactose and cane sugar. In milk slight acidity was produced without clot, in broth there was no indol fermentation. When first isolated no gas was formed in glucose and mannite. After subculture in the laboratory the strain acquired the property of gas formation in these media. The patient's serum in a dilution of 1 in 50 produced complete agglutination of *B. typhosus* and *B. paratyphosus* A. An emulsion of *B. paratyphosus* B was distinctly but not completely agglutinated. The serum agglutinated neither Shiga nor Flexner strains.

The bacillus was agglutinated shortly after isolation by our anti-paratyphoid A serum in a dilution of 1 in 200 but not in greater dilution. Since this serum produces marked agglutination with paratyphoid A emulsions in a dilution of 1 in 50,000, the result did

not appear of importance. We considered the bacillus a non-agglutinable paratyphoid A and made a report to that effect. Subsequently we carried out a long series of observations with this strain, the results of which are here summarized. In a complement fixation experiment we used extracts of the strain M and of our stock paratyphoid A strains and anti-paratyphoid A serum. With the M extract the antiserum gave a strong reaction in a dilution of 1 in 100 and traces in a dilution of 1 in 400. With the known paratyphoid A extract a complete reaction was obtained with a serum dilution of 1 in 1,600. An absorption experiment showed that an emulsion of bacillus M failed to remove the agglutinins for paratyphoid A from anti-paratyphoid A serum. It should be mentioned that the bacillus was not agglutinated by anti-typhoid serum. Subsequently we immunized a rabbit against this strain. The serum agglutinated emulsions of bacillus M in a dilution of 1 in 6,400 but failed to agglutinate paratyphoid A in a dilution of 1 in 50. Meanwhile the strain M had been subcultured daily for about a month and at the end of this period an agglutination experiment was performed. The anti-paratyphoid A serum produced complete agglutination of a known paratyphoid A strain in a dilution of 1 in 64,000, of the M strain in a dilution of 1 in 640. That is to say the result of subculture had been to greatly increase the agglutinability of the strain M with paratyphoid A serum. The agglutinability however, fell far short of that of a known strain of paratyphoid A. An emulsion in saline solution was not pathogenic for the guinea-pig. Our experiments with this strain are still being continued.

(2) The patient (G.) had had two typhoid inoculations. He landed at Cape Helles from Devonport on October 22 and remained in good health until the first week in December. During the early part of December he suffered from diarrhœa and headache, was treated at a field ambulance on December 18 and admitted to a base hospital on the beach a few days later. Arrived in Alexandria on December 26. The diagnosis was enteric fever. He was at a hospital at Cairo for five weeks and for four weeks in a convalescent camp.

At the time of examination he was completely convalescent. The bacillus isolated from the fæces resembled in morphological and cultural characteristics the members the *B. coli—B. typhosus* group. It was not motile. Glucose and mannite were fermented with formation of acid but not gas, but lactose and cane sugar were not. Litmus milk was slightly acid after twenty-four hours incu-

bation but appeared to become neutral on the second day. No alkali formation was observed. Indol was not formed. After subculture this strain acquired the property of producing gas in glucose and mannite peptone water. When first isolated the bacillus was not agglutinated by either anti-typhoid or anti-paratyphoid A serum in a dilution 1 in 100. Both these sera agglutinated their homologous strains in a dilution of 1 in 50,000. Three months after isolation the bacillus was agglutinated equally well by both anti-paratyphoid A and anti-paratyphoid B serum in dilutions of 1 in 160.

The patient's own serum in a dilution of 1 in 50 agglutinated emulsions of typhoid and paratyphoid B incompletely, and of paratyphoid A not at all. On the other hand, the patient's serum agglutinated his own bacillus completely in a dilution of 1 in 400, and to a slight extent in a dilution of 1 in 800.

In a subsequent experiment it was shown that the serum of this patient agglutinated his own strain, and that of the patient M. in a dilution of 1 in 800, and the strain isolated from the patient W. in a dilution of 1 in 200. This strain was not pathogenic for the guinea-pig.

(3) The patient (W.) had had two typhoid inoculations. He arrived at Suvla Bay on August 8, 1915. He was taken ill in September, and removed to the 3rd Australian Hospital at Lemnos. The illness lasted for ten weeks, and the clinical diagnosis was enteric fever. He was admitted to Hope Hospital on December 5. At the time of examination he was in good health. The bacillus was isolated on one occasion only, and had the following characteristics. It resembled in shape and staining reactions the *B. coli*—*B. typhosus* group. It was actively motile. It produced acid and a trace of gas in glucose and mannite. It had no action on cane sugar and lactose. It did not produce indol and it did not liquefy gelatin. It produced a slight acidity without clot in milk. Immediately after isolation an emulsion of this bacillus was put up with anti-paratyphoid A, anti-paratyphoid B, and anti-Gaertner sera in dilutions of 1 in 100. No agglutination was observed. About two months later the bacillus was agglutinated by a low dilution of anti-paratyphoid A serum, but not by anti-paratyphoid B serum. A rabbit was immunized against this strain, and the serum so obtained agglutinated its own bacillus in a dilution of 1 in 6,000. This serum agglutinated an emulsion of *B. paratyphosus* B in a dilution of 1 in 200, but failed to agglutinate *B. paratyphosus* A in a dilution of 1 in 25. The serum of this patient was not obtained,

as he was removed from Hope Hospital before our examination had been finished. This strain was not pathogenic for the guinea-pig.

(4) The patient (R.) had had two typhoid inoculations. He arrived in Egypt in March, 1915, and was transferred to Lemnos in August. On August 15 he was taken ill, admitted to the 18th Stationary Hospital, and diagnosed as enteric fever. The illness lasted three weeks. At the time of examination the patient was in good health.

The bacillus isolated from R. was a motile bacillus with the general cultural and morphological characteristics of this group of bacteria. It did not liquefy gelatine. It produced acid and gas in glucose and mannite. It did not ferment cane sugar and lactose. It did not form indol. Slight acidity without clot was produced in litmus milk. Anti-paratyphoid A and anti-paratyphoid B sera in dilutions of 1 in 50 failed to agglutinate this bacillus. Emulsions of the bacillus failed to remove agglutinins for paratyphoid A from anti-paratyphoid A serum. The patient's serum was not examined. A rabbit was immunized, but the serum while agglutinating the homologous bacillus in a dilution of 1 in 6,400 failed to agglutinate emulsions of paratyphoid A, paratyphoid B, and emulsions of bacilli isolated from M, G, and W. This strain was not pathogenic for the guinea-pig.

We have carried out a rather extensive series of experiments with the above four strains (M, G, W, and R), and hesitate at the present moment to express a definite opinion. The strains show a tendency to be modified in their characteristics as regards gas formation and agglutinability as a result of repeated subculture. Our investigations are being continued, and we are inclined to think that the strains M, G, and W, are closely related, are members of the paratyphoid group, and are distinct from either paratyphoid A or B. The strain R is probably a different variety.

Bacteria Resembling B. paratyphosus B.

(1) The patient (B.) had had two typhoid inoculations. He was taken ill on October 31, 1915. The illness lasted for about a week, and was accompanied by diarrhœa and the passage of blood in the motions.

This bacillus was a non-motile bacillus presenting the general characteristics common to the *B. typhosus—B. coli* group. It produced acid and gas in glucose and mannite. On litmus milk the reaction was at first acid, but became alkaline after ten days. It

did not produce indol, and it did not liquefy gelatine. It was not agglutinated by anti-paratyphoid A, anti-paratyphoid B, or anti-Gaertner serum.

(2) The patient (E.) had had two typhoid inoculations. He contracted dysentery at Suvla Bay and was sent to the 21st General Hospital at Alexandria. He contracted enteric fever on board ship on his way back to England.

This bacillus was isolated on four occasions from the fæces of the patient. It was a motile bacillus with the general characteristics of the paratyphoid group. Glucose and mannite were fermented with production of acid and gas. Cane sugar and lactose were not fermented. Milk was acidified in twenty-four hours and became alkaline on the third day. No indol was produced and gelatine was not liquefied. Anti-paratyphoid A, anti-paratyphoid B and anti-Gaertner serum failed to agglutinate an emulsion of this bacillus. The serum of the patient failed to agglutinate this strain but agglutinated in low dilution (1 in 50 to 1 in 200) emulsions of both paratyphoid A and paratyphoid B. A rabbit was injected with emulsions of this bacillus. The resulting serum failed to agglutinate the homologous strain. This strain was not pathogenic for the guinea-pig.

These two strains exhibited a similarity in cultural reactions to members of the *B. paratyphosus* B group.

Serum reactions entirely failed to establish any relationship between these strains and typical strains of the paratyphoid group. In addition to the above bacteria we isolated one strain which fermented glucose and mannite with acid and gas production, was motile, produced an alkaline reaction in milk and did not produce indol. This bacillus liquefied gelatine in about ten days and its investigation was discontinued.

Other Bacilli which did not ferment Lactose.

In the course of our work we isolated and examined a large number of strains which appeared as pale colonies on MacConkey plates. The majority are, no doubt, of little interest to the pathologist. We were, however, impressed by the fact that in a few cases the plates of some particular patient were on each occasion covered with pale colonies, and on each occasion the same bacillus was obtained in pure culture.

Strains having no Action on Glucose, Cane Sugar, Mannite and Lactose.

(1) Twenty-one strains showing the above reactions produced a definite alkaline reaction in milk. Indol was not formed and gelatine was not liquefied. These are the reactions of *B. fæcalis alkaligenes.*

(2) Two strains produced no change in litmus milk. Neither formed indol.

(3) One strain produced no change in litmus milk, but formed indol.

Serum was obtained in three cases, but in no case was agglutination observed with the bacillus isolated from the patient.

Strains producing Acid but not Gas in Glucose.

One strain was isolated which formed indol. The milk culture was slightly acid after twenty-four hours, after three days it became neutral. Gelatine was liquefied in three weeks.

Strains producing Acid and Gas in Glucose.

Thirteen strains fermented glucose with acid and gas production but had no action on cane sugar, mannite and lactose. Indol was produced. The reaction in milk differed slightly. In nine no change was observed, in three an alkaline, in one an acid reaction developed. From one patient a strain of this type was isolated on five occasions, from two on two, from the remainder on one occasion only. The plates of the patient from whom the bacillus was isolated on five occasions were always covered with pale colonies, all of which were presumably of this variety. The serum of this patient agglutinated an emulsion of this strain in a dilution of 1 in 200. Serum was obtained from four other patients but the agglutination reaction gave a negative result.

These strains appeared to be of some interest as the bacilli isolated closely resembled Morgan's No. 1 bacillus. We accordingly prepared an antiserum by injecting a rabbit with a culture of Morgan's bacillus. The serum from this animal agglutinated an emulsion of Morgan's bacillus in a dilution of 1 in 3,200, but only one of the strains isolated from our series of patients.

We next prepared an antiserum by injecting a rabbit with the strain B isolated from the patient who had produced a bacillus

of this type on five separate occasions. This serum agglutinated an emulsion of Morgan's No. 1 bacillus in a dilution of 1 in 600 and two of the strains which produced an alkaline reaction on milk were equally well agglutinated. The other strains, including that with which the rabbit had been immunized, were not agglutinated. These results are obviously not entirely satisfactory, but the case of the patient B., who produced a bacillus of this type on five separate occasions, appears to be of some interest.

Strains fermenting Glucose, Mannite and Cane Sugar.

A considerable number of bacilli were isolated which fermented these three sugars. Of these nine strains were isolated which fermented glucose, mannite and cane sugar with the production of acid only but not gas. No reaction took place in lactose. In litmus milk the strains showed some variation, in three cases an alkaline reaction occurred, in three the medium was rendered slightly acid, in the remaining cases no reaction occurred in milk. In broth indol was produced in all except one strain. In one case a strain of this type was isolated on three occasions, and in another case it was isolated twice. Emulsions of four of these strains were tested with serum from the patients, but no agglutination took place in a serum dilution of 1 in 50. Strains fermenting glucose, mannite, and cane sugar with the production of acid and gas were isolated in twenty-five cases. From one patient an organism of this type was isolated on four occasions. The plates in this case were often covered with pale colonies, presumably all similar, and were apparently free from lactose fermenting organisms. In one case the organism was isolated three times, and from another patient on two occasions. The reaction of nineteen strains in litmus milk was alkaline, of six it was either acid or neutral. Two of the twenty-five failed to give an indol reaction. Emulsions of six strains were tested against the patient's sera. In one case agglutination was observed in a dilution of 1 in 50, in one of 1 in 100. The strain which was isolated from the same man on four occasions was not agglutinated by the patient's own serum.

Late Lactose Fermenters.

All the following strains appeared as pale colonies on MacConkey plates :—

(1) This strain fermented glucose and mannite, producing acid but not gas. An acid reaction developed in lactose peptone water

after five to seven days' incubation, but cane sugar was not fermented. Litmus milk became alkaline after preliminary acidity. The organism formed indol but did not liquefy gelatine. The bacillus was not motile. It was isolated on four occasions from the same case, but was not agglutinated by the patient's own serum.

(2) Two strains were isolated which produced acid but not gas on glucose and cane sugar. Lactose was fermented by one strain after twenty-four hours, by the other strain after five days; mannite was not fermented. In litmus milk there was no change, in broth no indol. Gelatine was not liquefied. One of the strains was tested with the patient's own serum, but no agglutination was observed.

(3) Two strains were isolated which produced acid but not gas in glucose and lactose, and two strains which produced both acid and gas. In other respects these four strains resembled one another. Neither cane sugar nor mannite were fermented. Milk was clotted with an acid reaction and indol was produced.

(4) Ten strains produced acid but not gas in glucose, cane sugar, mannite and lactose, in milk acid and clot, in broth indol. One strain was isolated which produced an alkaline reaction in milk, but agreed in its other reactions with the above ten strains.

Blood Culture.

Blood cultures were made from seven of the carriers. About ten cubic centimetres of blood was taken and mixed with 100 cubic centimetres of broth. Plates were prepared after various intervals (up to six days) of incubation. The blood proved sterile in the case of six patients, who were in good health at the time of examination. One man, a paratyphoid carrier, was suffering from an acute illness, which was thought incorrectly to be a relapse, at the time of the examination. The *streptococcus mucosus* was isolated from the blood.

Agglutination Results.

We employed the usual and well-known macroscopic method (see Section on Methods). The results were read after twenty-four hours, and have been expressed on the table by the numerals 4, 3, 2, and 1. A complete reaction in which all the bacilli were precipitated in a firm mass leaving an absolutely clear supernatant fluid is expressed as 4. If the supernatant fluid was slightly opalescent the result is expressed as 3. A moderate deposit of agglu-

tinated bacteria with turbid supernatant fluid is expressed as 2. A small but quite definite deposit is expressed as 1. In every case a 1 in 25 dilution of the serum was mixed with an equal volume of the bacterial emulsion. The total dilution of the serum was therefore 1 in 50. The results obtained in experiments such as these depend greatly on the characteristics of the particular strain of bacillus which is used. In the case of our paratyphoid B and Bacillus Y strains we are not inclined to attach any importance to a less degree of agglutination than 3. The strains of typhoid, paratyphoid A, and Shiga showed no tendency to agglutinate with normal serum.

Typhoid.

The date of inoculation in all cases in which it was ascertained is given in the table. Practically all the patients had been inoculated. The agglutinins observed were probably the result of inoculation. In no case was *B. typhosus* isolated from the fæces. Of 322 cases 170 gave a complete reaction, 60 an almost complete reaction, 25 gave a marked reaction, and 7 a slight reaction. Of the 322, 3 only are known not to have been inoculated. In 24 cases the information was not obtained. That is to say, of 295 cases known to have been inoculated 23 failed in the agglutination test, while 230 gave a complete, or almost complete reaction in a dilution of 1 in 50. Our examination was carried out in March and April, 1916.

Paratyphoid A.

In the following summary of the results obtained by the examination of patients' serum, we have left out of account four cases which do not belong to the series, and in which the serum was examined after the isolation of a pathogenic bacillus from the fæces. The summary is based on the results of an examination of 317 unselected convalescents of whom 130 had been diagnosed as dysentery, 171 as enteric, while 16 were said to have had both enteric fever and dysentery.

Of the 171 enteric convalescents the reaction was complete in 13, almost complete in 4, well marked in 1. Of the 130 dysentery cases, almost complete in 1 and well marked in 1. Of 16 cases diagnosed as dysentery and enteric the reaction was well marked in 1. The approximate titre of 14 of these sera was determined :—

The titre	was	1	in	1,600	in	1	case
,,	,,	1	,,	800	,,	2	cases
,,	,,	1	,,	200	,,	7	,,
,,	,,	1	,,	100	,,	2	,,
,,	,,	1	,,	50	,,	2	,,

Several of these sera also reacted with paratyphoid B emulsions. The incidence of paratyphoid A infections as judged by agglutination results, including the 18 cases only in which the reaction in a serum dilution of 1 in 50 was complete or almost complete, was 10 per cent for enteric convalescents, 0·7 per cent for dysentery convalescents or 5·6 per cent for all convalescents.

Paratyphoid B.

Of 171 enteric convalescents the reaction was complete in 24, almost complete in 36, well marked in 36, and slight but definite in 9. Of the 131 dysentery convalescents the reaction was complete in 9, almost complete in 10, well marked in 4, and slight but definite in 1. Of 16 dysentery and enteric convalescents the reaction was complete in 2, almost complete in 3, and well marked in 4. The strain of *B. paratyphosus* B which we employed had a tendency to show a slight degree of non-specific agglutination with normal sera in low dilution. We have accordingly excluded all cases in which anything less than an almost complete reaction was obtained in a serum dilution of 1 in 50. The reaction was complete or almost complete in 84 cases. We made a second examination of 51 of these sera with the following results:—

The titre	was	1	in	1,600	in	10	cases
,,	,,	1	,,	800	,,	7	,,
,,	,,	1	,,	400	,,	9	,,
,,	,,	1	,,	200	,,	12	,,
,,	,,	1	,,	100	,,	13	,,

The incidence of paratyphoid B infection as estimated by the agglutination reaction was 35 per cent for enteric, 14·5 per cent for dysentery and 31·2 per cent for dysentery and enteric convalescents, or 26·4 per cent for all convalescents.

It seemed possible that some of the cases of enteritis might have been caused by bacteria belonging to the *B. enteritidis* (Gaertner) group. Seventy-three sera were tested with an emulsion of *B. enteritidis*. Of these three gave a marked reaction and three a slight reaction in a dilution of 1 in 50. Of these six sera five reacted far more strongly with *B. paratyphosus* B and the result obtained was regarded as a group reaction. The sixth serum was one of the three which gave a very slight reaction.

B. Dysenteriæ (Flexner Type).

The results of experiments carried out with a large number of sera were discarded as the particular strain of Flexner bacillus which we used proved to be quite unsuitable for the purpose. Emulsions of this bacillus were in fact readily agglutinated by normal serum in a dilution of 1 in 50. The following results were obtained with a strain of the Y type. The total number of sera tested with this strain was 190. Of 170 enteric cases the reaction was complete in 1, almost complete in 7, well marked in 11, and slight but definite in 9. Of 7 dysentery cases the reaction was almost complete in 2, and well marked in 2. Of 13 dysentery and enteric cases the reaction was complete in 1, and well marked in 1. Four of these sera were submitted to further examination :—

The titre was	1	in	200	in	1	case
,, ,,	1	,,	100	,,	2	cases
,, ,,	1	,,	50	,,	1	case

Excluding all cases except those in which the reaction was complete or almost complete we arrive at a percentage of 4·7 for the enteric cases. Unfortunately the number of dysentery cases examined with the satisfactory strain of Y bacillus was too small to allow of any definite conclusions.

B. Dysenteriæ (Shiga Type).

The total number of sera examined was 319. Of 171 cases diagnosed as enteric fever the reaction in a serum dilution of 1 in 50 was complete in 1, almost complete in 1, and well marked in 2. Of 132 cases diagnosed as dysentery the reaction was complete in 4, almost complete in 2, well marked in 1, and slight but definite in 1. Of 16 cases diagnosed as dysentery and enteric the reaction was almost complete in 1.

Seven of these sera were submitted to further examination :—

The titre was	1	in	200	in	1	case
,, ,,	1	,,	100	,,	1	,,
,, ,,	1	,,	50	,,	5	cases

The Shiga strain which we employed was free from any tendency to non-specific agglutination and we include all of the few cases which gave a reaction in a serum dilution of 1 in 50. The incidence of Shiga infection as judged by the agglutination reaction was 2·3 per cent for enteric convalescents and 6 per cent for dysentery convalescents, or 4 per cent for all cases.

DYSENTERY CASES.

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
2	2	—	0	0	0	—	0	—
3	2	February, 1915	0	0	0	—	0	—
4	2	—	2	0	0	—	0	*Lamblia intestinalis.*
5	2	Aug. and Sept., 1914	3	0	0	—	4	—
6	2	December, 1914 ..	3	0	0	—	0	—
9	2	May, 1915	4	0	3	—	0	Coccidian cysts.
10	2	—	3	0	0	—	0	Trichomonas.
11	—	--	4	0	0	—	0	—
12	2	—	2	0	0	—	0	*Entamœba coli, Macrostoma.*
13	2	—	3	0	3	—	0	*L. intestinalis.*
14	2	—	3	0	0	—	0	—
15	2	—	4	—	0	—	0	—
16	2	—	4	—	4	—	0	Coccidian cysts.
17	2	—	1	—	—	—	1	—
18	2	—	2	0	0	—	0	—
19	2	—	4	0	0	—	0	—
20	2	—	3	0	0	—	0	—
21	2	—	3	0	0	—	0	—
22	2	—	3	0	0	—	0	—
23	2	April, 1915	4	0	0	—	0	Cercomonas.
24	2	—	1	0	0	—	0	—
25	2	—	3	0	0	—	0	—
26	2	—	4	0	0	—	0	—
27	2	—	0	0	0	—	0	—
28	2	—	4	0	0	—	0	—
30	2	—	4	0	0	—	0	*L. intestinalis.*
31	2	—	4	0	0	—	0	—
32	2	—	4	0	0	—	4	—
33	2	—	4	0	0	—	2	—
34	2	—	0	0	0	—	0	*L. intestinalis.*
35	2	August, 1915	4	0	0	0	0	,, ,,
36	2	—	3	0	0	—	0	—
37	2	—	4	0	0	—	0	*L. intestinalis.*
38	2	—	4	0	0	—	0	—
39	2	—	0	0	0	—	0	*Bacillus dysenteriæ* (Flexner), *L. intestinalis.*
40	2	—	0	0	0	—	0	Macrostoma.
41	2	—	1	0	0	—	0	—
42	2	—	4	0	0	—	0	*L. intestinalis.*
43	2	—	4	0	0	—	0	*E. histolytica.*
44	2	—	0	0	0	—	0	*L. intestinalis.*
47	2	March, 1915	3	0	0	—	0	—
49	2	—	4	0	0	—	0	*L. intestinalis.*
50	2	—	4	0	0	—	3	—
51	2	—	1	0	0	—	0	—
54	2	—	0	0	0	—	0	—
55	2	—	3	0	0	—	0	*L. intestinalis.*
56	2	—	0	0	4	—	0	—

DYSENTERY CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
57	2	—	4	0	0	—	0	*L. intestinalis.*
58	2	—	2	0	0	—	0	—
59	?	—	3	4	0	—	0	—
60	2	—	4	0	0	—	0	—
61	2	—	3	0	0	—	0	*E. coli.*
62	2	June, 1915	0	0	0	—	0	,,
64	2	February, 1915 ..	4	0	0	—	0	—
65	2	July, 1915	4	0	0	—	0	—
66	2	December, 1914 ..	4	0	0	—	0	*L. intestinalis.*
45	2	—	0	0	0	—	0	,, ,,
67	1	July, 1915	4	0	0	—	0	,, ,,
68	2	May and August, 1915	4	0	0	—	0	*E. histolytica, Macrostoma.*
70	2	April, 1915	4	0	0	—	0	*E. histolytica, L. intestinalis.*
71	2	September, 1915 ..	3	0	4	—	0	—
72	2	August, 1915	4	0	0	—	0	—
73	2	May, 1915	4	0	0	—	0	*E. coli.*
74	2	Aug. and Sept., 1914 ..	4	0	1	—	0	—
75	1	September, 1915 ..	4	0	0	—	3	—
76	2	May, 1915	0	0	0	—	4	*B. dysenteriæ* (Shiga).
78	2	December, 1914 ..	4	0	0	—	0	—
79	2	July, 1914	2	0	0	—	0	*E. coli, Macrostoma.*
80	3	2 in December, 1914; 1 in August, 1915	0	0	3	—	0	—
81	2	June, 1915	4	0	2	—	4	—
82	2	July and Nov., 1914 ..	2	0	0	—	0	*L. intestinalis.*
83	1	August, 1915	4	0	4	—	0	*E. histolytica.*
84	2	August, 1915	4	0	3	—	0	—
85	2	July and August, 1915	4	0	0	—	0	*E. coli.*
86	2	August, 1914	4	0	0	—	0	*E. histolytica.*
87	2	April, 1915	4	0	0	—	0	—
94	2	July, 1915	0	0	0	—	0	—
95	0	—	0	0	0	—	0	—
97	2	November, 1914 ..	4	0	0	—	0	—
98	2	Oct., 1914; Aug., 1915	4	0	4	—	0	—
99	2	March, 1915	0	0	3	—	0	—
100	2	January, 1915	2	0	0	—	0	—
101	3	May and July, 1915 ..	4	0	3	—	0	—
102	2	September, 1914 ..	4	0	4	—	0	—
103	2	February, 1915 ..	4	0	0	—	0	—
105	2	September, 1914 ..	4	0	0	—	0	—
106	2	July, 1915	2	0	0	—	0	—
107	2	September, 1914 ..	4	0	3	—	0	—
108	2	July, 1914	4	0	0	—	0	Macrostoma.
109	2	September, 1914 ..	4	0	0	—	0	—
110	2	Sept. and Oct., 1914 ..	2	0	0	—	0	—
112	?	July, 1915	2	0	0	—	0	—
113	2	June, 1915	4	0	4	—	0	—
114	2	July and August, 1915	4	0	0	—	0	—

DYSENTERY CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
115	2	May, 1915	4	0	0	3	0	Trichomonas.
116	2	June, 1914	3	0	0	—	0	—
117	1	December, 1914 ..	0	0	0	—	0	*B. dysenteriæ* (Shiga).
118	2	August, 1914	3	0	0	—	0	*E. coli.*
119	3	June, 1915	4	0	2	—	0	—
121	1	July, 1915	4	0	0	—	0	—
122	2	August, 1915	4	0	2	2	0	—
124	2	March, 1915	4	0	3	0	0	—
126	2	March, 1915	3	0	0	—	0	—
127	2	1915	4	0	0	—	0	—
128	2	July, 1915	4	0	0	—	0	Macrostoma.
129	2	December, 1915 ..	4	0	0	—	0	*E. histolytica, L. intestinalis.*
131	?	—	3	0	0	—	0	—
133	—	—	0	0	0	—	0	—
134	2	July, 1915	4	0	0	—	0	—
135	1	—	3	4	0	—	0	*B. paratyphosus* A.
136	—	—	3	0	0	—	0	—
137	3	July, 1914	2	0	0	—	0	—
139	2	March, 1915	0	0	4	—	0	—
140	2	June, 1915	4	0	0	—	0	—
141	2	September, 1914 ..	4	0	0	—	0	—
142	2	—	0	0	0	—	0	—
143	2	April and May, 1914 ..	0	0	2	—	0	—
144	2	August, 1915	4	0	0	—	0	—
145	2	March, 1915	4	0	3	3	0	*B. dysenteriæ* Y.
147	2	November, 1914 ..	4	0	0	—	0	Trichomonas.
150	2	August, 1914	3	0	0	—	0	—
151	—	—	3	0	0	—	0	—
242	3	Jan., Mar., Aug., 1915..	2	0	3	0	0	*E. coli.*
243	2	March, 1915	0	0	0	—	0	*E. coli.*
244	2	January, 1915	2	0	0	2	0	—
250	1	—	4	0	0	—	0	—
251	2	—	4	0	4	—	0	—
252	2	—	4	0	0	—	0	—
253	2	—	4	0	0	—	0	—
255	2	—	4	0	0	—	0	*L. intestinalis, Macrostoma.*
256	2	—	4	3	0	—	0	Trichomonas.
257	2	—	4	0	0	—	0	*E. histolytica.*

DYSENTERY AND ENTERIC CASES.

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	*Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
154	2	—	3	0	0	0	0	—
156	2	—	2	0	4	0	0	—
157	2	—	3	0	0	0	0	—
158	2	January, 1915	4	0	0	0	0	*E. coli.*
159	2	March, 1914	4	0	4	0	0	—

DYSENTERY AND ENTERIC CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
160	2	October, 1914	4	0	3	0	0	—
161	2	October, 1914	4	0	3	4	0	—
162	2	November, 1914 ..	4	0	0	0	0	Trichomonas.
246	2	February, 1915 ..	3	0	3	0	0	—
247	2	September, 1914 ..	4	0	0	—	0	—
248	2	October, 1914	4	0	2	0	0	—
249	2	—	2	0	0	—	0	—
254	2	April, 1915	2	2	2	2	0	—
259	2	—	0	0	2	0	0	—
281	2	—	0	0	2	0	3	*B. dysenteriæ* (Shiga).
496	—	—	2	0	0	0	0	—

ENTERIC CASES.

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	*Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
164	2	—	0	0	0	0	0	—
166	0	—	0	0	0	0	0	—
167	2	—	4	0	0	0	0	*E. coli.*
171	2	—	4	0	0	0	0	*E. coli.*
173	1	—	4	3	0	0	0	—
174	2	—	0	0	0	0	0	—
179	2	—	0	0	0	0	0	—
181	—	—	0	0	0	0	0	—
187	2	—	0	0	4	0	0	—
188	2	—	1	0	2	0	0	Macrostoma.
191	2	September, 1915 ..	4	0	0	0	0	—
192	—	—	4	0	4	0	0	—
193	2	December, 1914 ..	0	0	0	0	0	—
194	2	September, 1914 ..	4	0	4	0	0	—
195	2	December, 1914 ..	2	0	4	0	0	—
196	2	October, 1914	3	0	4	0	0	—
197	2	October, 1914	4	0	3	0	0	—
198	2	September, 1915 ..	4	0	0	0	0	—
199	2	July, 1915	4	0	3	0	0	*E. coli.*
200	2	—	3	0	0	0	0	Macrostoma.
201	2	—	3	0	3	0	0	—
202	2	—	0	0	4	0	0	*L. intestinalis.*
203	2	—	0	0	0	0	0	—
205	2	1911	4	0	0	3	0	*B dysenteriæ* (Shiga).
206	2	—	4	0	0	0	0	—
207	2	—	0	4	0	2	0	—
208	—	—	4	0	3	3	0	—
209	2	—	0	0	0	0	0	—
212	2	—	3	0	4	0	0	—
213	2	—	4	0	0	0	0	—
215	2	—	4	0	4	—	0	*B. paratyphosus* B.
216	2	—	4	0	0	0	2	—
221	2	—	0	0	0	0	0	—
222	2	—	4	0	0	0	0	—

ENTERIC CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
223	2	—	4	4	3	0	0	—
224	2	—	4	0	0	0	0	—
225	2	—	4	0	0	0	0	—
226	2	—	3	0	0	0	0	—
227	2	August, 1915	0	0	0	0	0	—
228	2	June, 1915	4	0	2	2	0	—
229	2	September, 1914	3	0	4	0	0	*B. paratyphosus* B.
230	2	October, 1914	4	0	0	0	0	—
231	2	July, 1915	4	0	3	0	0	—
232	2	November, 1914	4	0	1	2	3	—
233	2	February, 1915	4	0	4	0	0	—
234	1	October, 1915	4	0	0	0	0	—
235	2	October, 1915	4	3	2	0	0	—
238	2	November, 1914	4	0	2	2	0	—
239	2	January, 1915	4	0	3	0	0	—
241	2	October, 1914	3	0	3	0	0	—
260	2	Dec., 1914 ; Feb., 1915	3	0	2	0	0	—
261	—	—	0	0	0	0	0	*E. coli.*
262	2	June, 1915	3	0	2	0	0	—
263	2	Jan. and Feb., 1915	4	0	3	0	0	*B. dysenteriæ* (Shiga).
264	2	February, 1915	4	0	0	0	0	—
265	2	April, 1915	3	0	0	4	0	—
266	2	January, 1915	4	0	0	1	0	—
267	2	September, 1914	4	0	3	0	0	—
268	2	August, 1914	4	0	0	0	0	—
269	2	—	2	0	2	0	0	—
270	2	—	2	0	3	0	0	—
271	2	—	4	0	0	0	0	—
272	—	—	0	0	2	0	0	—
274	2	October, 1914	4	0	3	2	0	—
276	2	—	4	4	4	0	0	—
278	2	June, 1915	4	0	4	0	0	—
279	2	June, 1915	4	0	2	0	0	—
280	2	December, 1914	4	0	1	2	0	—
282	2	October, 1914	1	0	1	0	0	—
283	2	July, 1915	4	0	0	1	0	*E. histolytica.*
284	2	February, 1915	4	4	0	0	0	—
285	2	November, 1914	4	0	4	3	0	—
286	2	November, 1914	0	0	1	0	0	—
287	2	Aug. and Sept., 1915	4	3	0	0	0	—
289	?	September, 1915	0	0	2	0	0	—
290	?	June, 1915	4	0	2	0	0	—
291	2	August, 1915	0	0	0	0	0	—
292	—	May, 1915	4	0	2	0	0	*E. coli.*
293	—	1915	4	0	0	0	0	—
294	2	October, 1915	4	0	3	0	0	*L. intestinalis.*
295	2	May, 1915	3	0	4	0	0	—
296	—	October, 1915	0	4	4	3	0	—
297	2	August, 1914	0	0	0	0	0	—
298	2	September, 1914	0	0	2	0	0	—

ENTERIC CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriæ* Y	*B. dysenteriæ* (Shiga)	Bacteria and protozoa found
299	2	October, 1914	4	0	3	0	0	—
300	2	October, 1914	0	0	0	0	0	*E. coli.*
301	?	September, 1915 ..	3	0	0	1	0	*L. intestinalis.*
302	2	March, 1915	4	0	3	0	0	—
303	2	Feb. and March, 1915	0	0	0	0	0	—
304	?	June, 1915	4	0	0	0	0	—
305	2	October, 1914	0	0	0	0	0	—
306	2	April, 1914	3	3	2	0	0	*B. paratyphosus* A.
307	2	November, 1914 ..	3	0	2	0	0	—
308	?	March, 1915	4	0	1	0	0	—
309	2	May, 1915	3	0	1	0	0	—
310	2	June, 1915	2	0	1	0	0	*E. histolytica.*
312	?	February, 1915 ..	3	4	4	0	0	—
313	2	February, 1915 ..	4	0	2	0	0	—
314	?	April, 1915	3	4	4	0	0	*E. coli.*
316	?	January, 1916	4	0	3	0	0	*E. coli.*
317	2	October, 1915	0	4	0	1	0	—
318	1	July, 1915	3	0	0	0	0	—
319	2	November, 1915 ..	3	0	2	0	0	*E. coli.*
320	2	December, 1915 ..	4	2	2	0	0	—
321	2	February, 1916 ..	3	0	1	1	0	—
322	1	December, 1915 ..	0	0	1	0	0	—
323	—	—	0	0	0	0	0	*L. intestinalis.*
324	2	March, 1915	3	0	3	1	0	—
325	?	April, 1915	0	0	0	0	0	—
327	2	Oct., 1914, Feb., 1915	4	0	3	0	0	—
328	2	September, 1915 ..	0	0	0	0	0	*E. coli.*
329	?	March, 1916	3	0	2	0	0	—
330	2	October, 1915	2	0	0	0	0	—
331	2	October, 1915	3	0	0	0	0	—
332	2	September, 1915 ..	4	0	4	0	0	—
333	2	August, 1915	3	0	4	0	0	—
334	2	May, 1915	2	0	3	0	0	*E. coli.*
335	2	Feb. and March, 1915..	4	4	0	0	0	*B. paratyphosus* A.
336	2	September, 1915 ..	0	0	0	0	0	—
337	2	June, 1915	0	0	0	0	0	—
338	2	December, 1914 ..	4	0	3	2	0	*L. intestinalis.*
339	2	March, 1915	2	0	0	0	0	—
342	2	March, 1915	4	0	3	0	0	Macrostoma.
344	2	August, 1915	3	0	0	0	0	—
345	1	February, 1915.. ..	3	0	2	0	0	—
346	2	March, 1915	4	0	0	0	0	—
347	—	—	4	0	0	0	0	—
348	—	—	4	0	2	0	0	—
349	—	—	4	0	3	0	0	*E. histolytica, Macrostoma.*
350	2	January, 1916	3	0	4	3	0	*E. histolytica.*
351	2	June, 1915	4	0	2	0	0	*L. intestinalis.*
352	2	September, 1914 ..	0	0	2	0	0	—
353	2	October, 1915	4	0	2	0	0	—

ENTERIC CASES—*continued.*

Laboratory number	Number of typhoid inoculations	Date of typhoid inoculations	Agglutination Results: *Bacillus typhosus*	*B. paratyphosus* A	*B. paratyphosus* B	*B. dysenteriae* Y	*B. dysenteriae* (Shiga)	Bacteria and protozoa found
354	2	September, 1915 ..	4	0	3	0	0	—
355	2	June, 1915	4	0	2	0	0	—
356	2	August, 1915	0	0	3	0	0	—
357	2	Nov., 1914; Feb., 1915	4	4	3	0	0	—
358	1	June, 1915	4	0	0	0	0	—
359	0	—	0	0	0	0	0	—
360	—	—	2	0	3	1	0	—
361	2	November, 1914 ..	0	0	0	0	0	—
362	—	—	4	4	0	3	0	—
363	2	Sept., 1914; Aug., 1915	4	4	2	0	0	—
364	2	November, 1915 ..	4	0	3	0	0	—
365	2	July and Sept., 1915 ..	4	0	3	0	0	—
366	2	Aug. and Sept., 1915 ..	4	0	3	0	0	—
367	2	May, 1915	4	0	0	0	0	—
368	2	November, 1915 ..	4	0	2	1	0	—
369	2	March, 1915	4	0	3	0	4	—
370	2	February, 1915.. ..	3	0	3	0	0	—
371	2	October, 1914	3	0	0	0	0	—
377	2	November, 1914 ..	4	0	4	0	0	*L. intestinalis.*
378	2	May, 1915	4	0	2	2	0	—
379	2	July, 1915	4	0	3	2	0	—
380	2	October, 1915	3	0	0	0	0	*L. intestinalis.*
381	2	March, 1915	4	4	3	2	0	—
382	2	March, 1915	4	0	4	1	0	—
383	2	January, 1915	2	0	3	0	0	—
385	—	—	4	0	2	3	0	—
386	—	—	3	0	0	0	0	—
387	2	September, 1915 ..	4	0	4	0	2	
390	—	—	4	0	2	0	0	—
391	2	May, 1915	4	0	3	0	0	—
392	2	May and June, 1915 ..	3	0	2	0	0	—
393	—	—	3	0	2	0	0	—
394	2	April, 1915	4	0	3	0	0	—
395	2	August, 1915	4	0	3	0	0	—
396	2	Sept., 1914; July, 1915	4	0	2	0	0	—
397	—	—	4	0	4	0	0	—
398	2	November, 1914 ..	0	0	2	0	0	—
400	2	April, 1915	2	0	2	2	0	—

PROTOZOA.

By R. Williamson.

Microscopic examinations were made of 180 convalescents who had been diagnosed as dysentery. The majority were examined on three occasions and in several cases additional examinations were made. The result of these examinations is given in Table II.

TABLE II.—Dysentery and Dysentery and Enteric.

Number of cases	180
,, examinations	589
,, cases in which parasites were found	53
,, ,, ,, *E. histolytica* was found	8
,, ,, ,, *E. coli* was found	15
,, ,, ,, *Lamblia* was found	21
,, ,, ,, *Macrostoma* was found	8
,, ,, ,, *Trichomonas* was found	4
,, ,, ,, *Cercomonas* was found	1
,, ,, ,, Coccidian cysts were found	2
,, ,, ,, *Trichocephalus* eggs were found	2
Mixed infections	8
E. coli and *Macrostoma*	2
,, ,, *E. histolytica*	1
E. histolytica and *Macrostoma*	1
,, ,, *Lamblia*	2
L. intestinalis and *Macrostoma*	2

As from several of our cases, in which a diagnosis of enteric fever had been made, bacilli of the Shiga type were isolated, it was thought desirable to make a microscopical examination of the fæces of such of the enteric cases as had not been discharged. The results of this examination are shown in Table III.

TABLE III.—Enteric Cases.

Number of cases	259
,, examinations	327
,, cases in which parasites were found	42
,, ,, ,, *E. histolytica* was found	7
,, ,, ,, *E. coli* was found	18
,, ,, ,, *Lamblia* was found	14
,, ,, ,, *Macrostoma* was found	6
,, ,, ,, *Trichomonas* was found	1
,, ,, ,, *Cercomonas* was found	0
,, ,, ,, Coccidian cysts were found	0
,, ,, ,, *Trichocephalus* eggs were found	0
,, mixed infections	3
E. coli and *Macrostoma*	1
,, ,, *E. histolytica*	1
E. histolytica and *Macrostoma*	1

Methods.

Specimens of fæces were collected and placed in an incubator. As a rule about three hours elapsed before the examination was made. Neutral red in the proportion of 1 to 10,000 parts of normal saline solution was used to dilute the fæces. Both the saline solution and the glass slides were brought to a temperature of 40° C. before use. In some cases permanent preparations were made. Wet films were fixed in hot Schaudinn's fluid for five minutes. They were then stained by Heidenhain's iron alum hæmatoxylin or by hæmalum.

Entamœba histolytica.

This parasite was found in 8 of the 180 cases (4·4 per cent) diagnosed as dysentery, and in 7 of 259 cases (2·7 per cent) diagnosed as enteric fever. The majority of the enteric cases were only examined once, while the majority of the dysentery cases had three or more examinations. In one case only was *E. histolytica* found together with a pathogenic bacillus, (*B. paratyphosus* B).

Except in Case 86, the appearances observed corresponded to the usual descriptions of the parasite. Both cysts and active forms were frequently observed.

Notes on Amœba Carriers.

No. 43. Dysentery at Suvla Bay, September 29, 1915. Stated to have had two injections of emetine. Had had diarrhœa with hæmorrhage in fæces in Egypt. Tetragena cysts and vegetative phases observed January 12, February 9 and 15, and March 3. Six one-grain doses of emetine March 7 to March 14. Very few amœbæ found March 13. Examinations April 25, June 8 and 15 were negative. Patient's serum agglutinated *B. typhosus* only. Condition at time of admission good, stools normal, but three motions a day.

No. 83. Dysentery at Suvla Bay, September 27, 1915. Stated to have had twelve injections of emetine. Examination January 13 negative. January 27 and February 7 few amœbæ found. Examination March 3 negative. Six grains of emetine injected March 7 to March 14. Examinations March 13, April 25, June 8 and 15 negative. The patient's serum agglutinated *B. typhosus* and *B. paratyphosus* B. Condition on admission good, motions one or two daily and appearance normal.

No. 86. Dysentery at Alexandria, October 11, 1915, where three

injections of emetine were given. Amœbæ observed on January 27, February 7 and 25, and March 13. The amœbæ were smaller than typical *E. histolytica* and usually spherical. A few active forms were seen. The nucleus was invisible, but ectoplasm and endoplasm were not sharply differentiated. No cysts were found. This parasite corresponded in some respects with the description of *E. minuta*. Six grains of emetine given March 7 to 14. Amœbæ observed on April 25. Six doses of emetine given May 1 to May 8. Examinations on June 6, 15 and 21 were negative. The serum agglutinated *B. typhosus* only. Condition on admission was good. Stools normal.

No. 68. Dysentery, Cape Helles, September 9, 1915.—Amœbæ found on January 13 and 31, February 8, March 3. Six injections of emetine March 2 to 9. Amœbæ observed March 13, April 25, June 6 and 15. A second course of emetine injections was given in May. In addition to *E. histolytica* the fæces contained large numbers of *Macrostoma*. The amœbæ observed after the emetine were few in number and appeared to be degenerate. Emetine had no influence on *Macrostoma*. The serum agglutinated *B. typhosus*, The patient was in good condition on admission. The number of motions was four to five daily.

No. 70. Dysentery, Suvla Bay, October 2, 1915.—Lamblia cysts found on January 13 and 27. On February 7 *Lamblia* cysts and *E. histolytica* were found, and on March 3 *Lamblia* cysts only were found. After this date *Lamblia* disappeared. Examinations made on March 13 and April 25 proved negative. On June 15, *E. histolytica* was again found, but was absent on June 21 and July 5. Twelve grains of emetine were given commencing on July 7, but the patient was transferred before further examinations could be made. The serum agglutinated *B. typhosus* only. On admission the patient's condition was good but he had not quite regained weight. He was said to have had enteric one month after dysentery.

No. 138. Dysentery at Suvla Bay at the beginning of November, 1915. Stated to have had emetine at Malta. Cysts and vegetative phases of *E. coli* were found on January 19 and February 16 and 21, on March 3 and April 25 in addition to *E. coli* a few active specimens of *E. histolytica* were found. On June 6, 15 and 21 only *E. coli* was found. Whether he had had emetine between April 25 and June 6 is uncertain. Agglutination reaction was not tested. Patient's condition on admission was good.

No. 257. Dysentery, Suvla Bay, September 15, 1915. Had had injections of emetine. A few cysts and vegetative forms of

E. histolytica were found on February 2, 8 and 21. The patient was discharged before further examinations could be made. Serum agglutinated *B. typhosus* only. Patient's condition on admission was good.

No. 129. Dysentery, Capt. Helles, early in September, 1915. Had had injections of emetine on the Peninsula. A few specimens of *E. histolytica* were found on February 10, 16 and 23 and on June 6. On June 15 and 21 no amœbæ were seen, but a few *Lamblia* cysts were present on June 15. On July 5 *E. histolytica* and a few *Lamblia* cysts were seen. Twelve one-grain doses of emetine were started on July 7 but the patient was transferred before other examinations could be made. The serum was not examined. The patient was in good condition on admission.

No. 350. Enteric, Peninsula, end of November, 1915. A few specimens of *E. histolytica* were found on March 29 and May 10. On May 17 the examination was negative but on June 7 *E. histolytica* was again found. An examination made on June 15 was negative but on June 21 a few active *E. histolytica* were found. A negative result was obtained on July 5. On July 7 the patient was started on a course of twelve one-grain doses of emetine. The patient was transferred before further examinations could be made. Patient's serum agglutinated *B. typhosus*, *B. paratyphosus* B and bacillus Y. The patient had four days diarrhœa with abdominal pains commencing May 19.

No. 349. This man was admitted to Hope Hospital as an enteric convalescent. According to patient's story he had had dysentery at Suvla Bay, November 18, 1915 and was sent to St. John's Hospital, Malta, where he developed enteric fever. On March 29 and May 3 *E. histolytica* and *Macrostoma* observed. Six grains of emetine were injected between May 3 and May 10. The examination was negative on May 10 as regards both parasites but positive on May 17. On June 6 and 15 *E. histolytica* was not found. *Macrostoma* was present on the 6th. Both parasites were found on June 21 and July 5. On July 7 a course of twelve injections of emetine was commenced. The patient was shortly afterwards removed from Hope. The serum agglutinated *B. typhosus* and *B. paratyphosus* B. The patient's condition was good except for a chronic sinus of lower jaw, which appeared to improve markedly after emetine injections.

No. 283. Developed jaundice in October, 1915, at Suvla Bay, treated at field ambulance and returned to duty, subsequently sent to hospital at Malta for "trench foot," developed enteric in hospital.

E. histolytica was found on March 30 and May 10 but not on June 6 and May 21. Serum agglutinated *B. typhosus*. On admission the patient was very weak and thin. He suffered from constipation during stay in Hope Hospital.

No. 392. Enteric at Salonica, November 1915, in hospital at Cairo 11 weeks. *E. histolytica* found April 26. Negative results obtained on May 10 and June 6. Positive results on June 15 and June 21. The serum agglutinated *B. typhosus*. The patient's condition was good at time of examinations.

No. 446. Developed diarrhœa on ship leaving Gallipoli Peninsula. Admitted to 15th General Hospital at Alexandria on December 25 (diagnosis, diarrhœa and pyrexia). In this hospital three weeks, then at convalescent camp, and then two weeks at base camp. Admitted 17th General Hospital at Alexandria as case of enteric fever. *E. histolytica* was found on May 9 and 17, but not on June 6, 15 and 21. Cysts of *E. coli* observed at examination on May 9. The patient suffered from constipation during stay in hospital.

No. 310. Invalided from Gallipoli Peninsula with diarrhœa. Enteric fever at Alexandria, January 11, 1916. *E. histolytica* were present in large numbers in fæces on March 28 and 30, April 6 and 25, May 10 and 17. Six doses of emetine were given in June. On July 5 fewer amœbæ were found. Subsequently twelve more injections of emetine were given. The patient was removed from Hope in July. The serum agglutinated *B typhosus*. The patient's condition was good.

No. 429. In 17th General Hospital at Cape Helles with diagnosis of enteric fever. Subsequently sent to Cairo. *E. histolytica* found on April 27 and May 10. *B. paratyphosus* B isolated from fæces on April 17. Serum agglutinated *B. typhosus* and *B. paratyphosus* B.

Emetine Treatment of Carriers.

Several of the cases were removed to dysentery camps before the results of emetine treatment could be appreciated.

In the case of six patients the results above given provide data of some interest. In three cases the parasite disappeared from the fæces, and three negative results were obtained, the last of which was at least three months later than the date of the emetine injections. In one Case (68) the injections appeared to have little, if any, influence on the condition. In two Cases (70 and 349) the examinations immediately following the course of injections were negative, but the parasite subsequently reappeared.

Entamœba coli.

This parasite was observed in 15 of the 180 dysentery cases, and in 18 of the 259 enteric cases. In the majority of cases very few amœbæ were seen. In nearly every case a few cysts were seen as well as the vegetative forms. In two patients both *E. coli* and *E. histolytica* were found.

Lamblia intestinalis.

This parasite was observed in 35 of 439 cases; 180 had been diagnosed as dysentery, and almost all were examined on at least three occasions, and the parasite was found in 21 cases. Fifty-nine had been diagnosed as enteric fever, the majority had only one microscopical examination, and the parasite was found in fourteen cases. Of the dysentery cases the *Lamblia* was found in 3 of 3 examinations in 7 cases, in 2 of 3 examinations in 9 cases, in 1 of 3 examinations in 5 cases. Of the enteric cases eleven were only examined once, three were examined twice, and the parasite was found on each occasion. Encysted forms usually occurred, but in five cases active forms were seen. In thirteen cases the cysts were numerous. Almost all the patients were in good health at the time of examination, but several suffered from diarrhœa during their stay in Hope Hospital. In this respect there was no striking difference between these patients and the other convalescents. From one of the thirty-five *B. dysenteriæ* (Flexner) was isolated. In two cases *E. histolytica* was observed. The serum of one patient strongly agglutinated *B. paratyphosus* A; of 4, *B. paratyphosus* B; that is to say, in 9 of the 35 cases there was good evidence of some other cause of disease.

Macrostoma.

This parasite was observed in 8 of the 180 dysentery and 6 of the 259 enteric cases. As a rule, very few *Macrostoma* were seen in each specimen, but occasionally they were very numerous. Active forms were far more numerous than cysts. In those cases in which the parasite occurred in large numbers it was found at almost every examination.

Mixed Infections.

(1) Patients who were found to be carriers of more than one pathogenic organism. Only two cases come under this heading. In one Case (429) *B. paratyphosus* B and *E. histolytica* were found.

A brief history of this case will be found among the notes on amœba carriers. In the other Case (424) both the Flexner and Y types of *B. dysenteriæ* appear to have been present in the same patient. An account of this case is given under that heading. The serum of this man agglutinated the Y bacillus and *B. paratyphosus* B.

(2) Carriers whose serum agglutinated emulsions of other pathogenic organisms.

Case	Clinical diagnosis	Organism found in fæces	Agglutination Results with Patient's Serum				
			Typhoid	Para-typhoid A	Para-typhoid B	Bacillus Y	Shiga
83	D	*E. histolytica* ..	4	0	4	—	0
349	E	,, ,, ..	4	0	3	0	0
350	E	,, ,, ..	3	0	4	3	0
145	D	Y bacillus ..	4	0	3	3	0
263	E	Shiga bacillus ..	4	0	3	0	0

Notes on 83, 349 and 350 will be found under heading of amœba carriers. In the case of 349 there is a definite history of dysentery contracted at Suvla Bay, and enteric in hospital at Malta. The histories of the other cases afford no evidence of double infection. It will be observed that two of the *E. histolytica* cases and the Shiga case were diagnosed as enteric fever.

(3) Patients whose serum definitely agglutinated more than one pathogenic bacillus.

Case	Clinical diagnosis	Agglutination Results with Patient's Serum				
		Typhoid	Paratyphoid A	Paratyphoid B	Y bacillus	Shiga
161	D and E	4	0	3	4	0
208	E	4	0	3	3	0
223	E	4	4	3	0	0
276	E	4	4	4	0	0
285	E	4	0	4	3	0
296	E	0	4	4	3	0
312	E	3	4	4	0	0
314	E	3	4	4	0	0
357	E	4	4	3	0	0
369	E	4	0	3	0	4
381	E	4	4	3	2	0
387	E	4	0	4	0	2

Sera from two cases diagnosed as enteric fever agglutinated the Shiga bacillus and the Paratyphoid B bacillus. Patient 369 contracted enteric fever on the Peninsula in November, was sent to Cairo, where he had a "relapse." Patient 387 contracted enteric fever at Salonica on October 27. Sera from five cases agglutinated paratyphoid B and bacillus Y. One case (161) was diagnosed clinically as enteric fever and dysentery. The other three patients were diagnosed as enteric fever, and such particulars of them as are in our possession afford no evidence of double infection. Sera from seven cases agglutinated emulsions of both paratyphoid A and B. One of these was the patient M., and some account of this case, and of the bacillus which was isolated, is given under the heading of bacilli belonging to the paratyphoid group. We consider this bacillus to be closely allied to, but a separate variety from *B paratyphosus* A.

Higher dilutions from 1 in 100 to 1 in 1,600 were prepared from five of these sera. In one case (312) paratyphoid A was agglutinated in a dilution of 1 in 100, paratyphoid B in a dilution of 1 in 1,600. In the other cases the differences in the titre of the serum with emulsions of paratyphoid A and B were inconsiderable, and we were unable to arrive at any definite conclusion.

Summary.

Four hundred and eighty-eight cases from the Mediterranean Force were examined. Of these 308 had been diagnosed as enteric fever, 160 as dysentery, and 20 as dysentery and enteric. In no case was *B. typhosus* isolated from either fæces or urine.

B. paratyphosus A was isolated from 3 cases, in 2 cases from fæces, in 1 case from urine. Two cases had been diagnosed as enteric fever and one as dysentery. Serum from these patients agglutinated an emulsion of paratyphosus A.

B. paratyphosus B was isolated from three cases, all of which had been diagnosed as enteric fever, and in all three cases the bacillus was found in the fæces. Serum from these patients agglutinated an emulsion of *B. paratyphosus* B.

B. dysenteriæ (Flexner and Y types).—Strains fermenting maltose were isolated from two patients. The serum from one of these agglutinated an emulsion of the stock Y bacillus.

Strains which did not ferment maltose were isolated from two cases. The serum from one of these patients agglutinated the stock Y bacillus.

From one patient were isolated two strains, one of which fer-

mented maltose, while the other did not. The serum of the patient agglutinated the Y strain, but not the Flexner strain.

B. dysenteriæ (Shiga type) was isolated from six of the 488 cases. Of these 2 had been diagnosed as dysentery, 3 as enteric fever, and 1 as dysentery and enteric. The serum from three of these patients agglutinated an emulsion of the stock Shiga bacillus.

E. histolytica was found in fifteen of 439 cases. Of these seven had been diagnosed as enteric fever and eight as either dysentery or dysentery and enteric.

Of 488 convalescents 3 were found to harbour *B. paratyphosus* A, 3 *B. paratyphosus* B, 5 *B. dysenteriæ* (Flexner) 6 *B. dysenteriæ* (Shiga), and 15 *E. histolytica*. Only 259 of the 308 enteric cases were examined for amœbæ. The total number of carriers among the 488 was 32, that is to say, rather more than 6·5 per cent.

Other Bacilli.—Six strains were isolated which were probably members of the paratyphoid family. Investigations of these strains are being continued. In many other cases the MacConkey plates were covered with pale colonies, which proved to be varieties of bacilli not as yet associated with pathological changes. A short account of the strains which were isolated and examined has been given above.

The results attained by an examination of the sera of unselected cases may be summarized as follows. No slight or doubtful reactions have been included :—

Paratyphoid A.

Number of cases		Positive reactions	Percentage
Enteric	171	17	10
Dysentery	130	1	0·7
Enteric and dysentery	16	0	—
All cases	317	18	5·6

Paratyphoid B.

Number of cases		Positive reactions	Percentage
Enteric	171	60	35
Dysentery	131	19	14·5
Enteric and dysentery	16	5	—
All cases	318	84	26·4

Y bacillus.

Number of cases		Positive reactions	Percentage
Enteric	170	8	4·7
Dysentery	7	2	—
Enteric and dysentery	13	1	—
All cases	190	11	5.7

Shiga bacillus.

Number of cases		Positive reactions	Percentage
Enteric	171	4	2·3
Dysentery	132	8	6
Enteric and dysentery	16	1	—
All cases	319	13	4

The number of sera which strongly agglutinated the two varieties of paratyphoid bacilli A and B was large, and if only those cases are included in which a very strong reaction was obtained, we arrive at the conclusion that thirty-three per cent of all patients had suffered from paratyphoid infections. The percentage for patients clinically diagnosed as enteric is forty-five.

The figures obtained with the two types of dysentery bacilli are much lower. Here the results obtained by the agglutination method probably do not provide a reliable index of the prevalence of bacterial dysentery. The serum of only half of the dysentery carriers agglutinated the homologous strain of dysentery bacillus. Moreover, the titres of the sera which did agglutinate either bacillus Y or the Shiga bacillus were much lower than the titres of most of the sera which agglutinated the two varieties of paratyphoid.

The cases of amœbic dysentery treated by emetine were hardly numerous enough to afford valuable information. The results obtained appeared to show that emetine injections produced the disappearance or reduction in numbers of the parasite. In a few cases however, the parasites, after an interval, reappeared.

The fact that *B. typhosus* was in no case isolated from either fæces or urine is evidence of the value of preventive inoculation.

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F.* (*January to August*, 1916).]

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(*Continued from page* 370.)

CONTENTS.

Part III.

PART III.

Treatment of E. histolytica and other Protozoal Infections of the Human Intestine.

This part of the report is devoted to a consideration of the action of drugs on the various intestinal protozoal infections met with in man in Alexandria. The chief objective was the treatment and cure of *E. histolytica* infections, but as many of them were mixed with other protozoal infections it was possible to watch on these also the action of emetin or other drugs employed. The various protozoa, as regards their behaviour under treatment, will be now considered, while the charts showing the courses of the various infections in the individual cases treated appear at the end of the report.

(1) *Treatment of Entamœba histolytica Infections.*

The line of treatment adopted for *E. histolytica* infections has been almost exclusively the administration of emetin hydrochloride either by subcutaneous injection or by the mouth. In a few cases we have given methyl emetin sulphate which was prepared by Dr. Pyman, Director of the Chemical Research Laboratories, Wellcome Bureau of Scientific Research, and kindly placed at our disposal by him. One case which resisted emetin treatment was given treatment by pulv. ipecac. and later by thymol.

The majority of the cases have been healthy carriers who were mostly discovered during the routine examination of men in camps as explained earlier in this paper. Some of these were encountered during the examination of hospital cases which had been admitted for various reasons. In addition to the carriers a smaller number of cases of actual amœbic dysentery were treated, and by amœbic

dysentery we mean a condition associated with the occurrence of blood and mucus in the stool with the presence of amœbæ showing definite included red blood corpuscles. We have included no doubtful cases in this list, such as might possibly be bacillary dysentery with free forms of *E. coli*, but all have been undoubted cases of *E. histolytica* infection which have been diagnosed according to the system explained in another part of the paper.

The cases have all been treated as hospital patients with the exception of four, who continued their duties as usual during the course of emetin.

The stools were in almost every instance examined for a few days before treatment was commenced in order to obtain some idea of the course of the infection before an attempt was made to get rid of it, and a careful record was kept of the kind of stool passed and the various other protozoal infections present besides the *E. histolytica*. While the patients were in hospital at least one entire stool was inspected each day, an arrangement having been made whereby the stools passed into bed-pans were brought at once to a lavatory near the laboratory which was set apart for this purpose. After the course of treatment was completed the patients were sent to a convalescent camp and were quartered in a special section. Here they were given ordinary diet and were placed on light duty. Stools were collected from them on alternate days. As will be seen from the records of the cases at the end of the paper it was possible in this way to follow exactly the effect that treatment had upon the infection and to note when any return of this occurred.

Each case was kept under control for at least one month after the completion of the course of emetin before being discharged as cured. Of course an unavoidable fallacy entered into the control and that was the impossibility of excluding the chance of reinfection. That infection might occur in the convalescent camp is shown very clearly in some cases by the fact that certain protozoa not hitherto present in the stools appeared a few days after the patients had joined the camp. That this may have occurred equally well with *E. histolytica* we recognize quite clearly, but if it has done so in any case it can only have had the effect of making our results worse than they actually appear.

In carrying out the treatment we have had direct control of all the cases owing to the kindness of the hospital authorities in placing beds at our disposal for this purpose. The temperature and pulse-rate of the cases were taken regularly and a careful

watch was kept for any signs of heart irregularity which might be attributable to the emetin which was being administered. A record was kept of the number of times patients vomited after emetin was administered by the mouth.

The observations on the series of cases here recorded have occupied about six months and have entailed an enormous number of stool examinations, as can very readily be seen from the protocols of the cases, but the results we have obtained throw light not only on the course of the *E. histolytica* infections and the effect emetin has on these but has brought out many other interesting points in connexion with other protozoal infections of the human intestine.

Treatment by Emetin Hydrochloride.—The emetin used in these observations was the tabloid product of Messrs. Burroughs Wellcome and Co. For injection purposes it was dissolved in the strength of one grain in one cubic centimetre of distilled water. For oral administration we employed the same product, one grain dissolved in tinct. opii fifteen minims, or the half-grain keratin-coated tabloids. Emetin administered subcutaneously was always given in one single injection daily, as this causes far less worry to the patient, who naturally does not like to have his injections unnecessarily multiplied, and, furthermore, it saves the labour of those who have to give the drug. It has yet to be proved that two injections of half a grain a day are better in any way than a single injection of one grain. The cases we have treated fall naturally into three groups according to the method of emetin administration. In Group I the cases were in hospital with four exceptions. They were not kept in bed entirely but were allowed about during the greater part of the day. They were given hospital chicken diet and were treated by the administration of a single injection of one grain of emetin a day for twelve days, while the bowels were kept loose by a mixture containing sodium sulphate, one dram taken three or four times a day.

In Group II the cases were treated in the same manner as those in Group I, with the difference that the drug was given by the mouth instead of by injection. The emetin was dissolved in tinct. opii one grain in fifteen minims, and this was given each night in a cup of tea. The salines were not given so regularly, as the emetin by the mouth tends to keep the bowels loose.

In Group III the cases were confined strictly to bed, were kept on milk diet and were given 1½ grains of emetin a day for twelve days (one grain injection each morning and half a grain in keratin-coated tabloid by the mouth at night). In this group of cases

salines were not administered regularly but were given if there was any sign of the stool being formed. In addition to the cases which fall into these three groups there are others which were treated differently, and these will be described in due course.

In the early part of our investigation the cases were treated as in Groups I and II, and, as the tables show, certain cases relapsed, and some of these were re-admitted to hospital and treated as in Group III. In recording the results of the different methods of treatment it follows that such cases will appear, in two tables, for it has happened that where treatment as in Group I has failed to bring about a permanent or even temporary cure, a subsequent treatment by another method has caused the infection to disappear in many cases.

Group I.—Cases treated by Emetin Injections of One Grain a Day for Twelve Days. Table X.

As already explained, these cases were given an injection of one grain of emetin a day for twelve days. The reason for adopting this line of treatment and the arbitrary limit of twelve days was that one of us (C. M. W.) made a detailed study of a case which was under his care and was treated in this way with a successful result in London last year at the Wellcome Bureau of Scientific Research. The case was one of a carrier of *E. histolytica* who was passing cysts after having had an attack of dysentery in the Sudan. It was realized that the case afforded a good opportunity of watching the course of such an infection and studying the effect of emetin on the carrier. The case was carefully controlled by repeated examination of the fæces and, finally, it was decided to give the patient a course of emetine. The actual injections were kindly given by Dr. G. C. Low in the Laboratory at the Wellcome Bureau of Scientific Research, while the control of the infection was carried on carefully as before. It was noted that the infection disappeared after the second injection of emetin and that there was no recurrence after a long period of control. The findings of the one of us (C. M. W.), who had gone abroad on active service, and who had made the very careful observations on this case, were subsequently published by Dr. G. C. Low (*Journ. Trop. Med. and Hygiene*, February 1, 1916).

As the case just mentioned had responded so successfully to this line of treatment it was decided to try it on a more extended scale, and this was the first method adopted by us in the series of

cases recorded here. The cases treated and the results obtained are arranged in Table X in two main groups: (A), carrier cases which were passing cysts of *E. histolytica* and amœbæ without included red blood corpuscles, in stools free from blood and mucus, and (B), acute cases which had actual dysentery and were passing amœbæ with included red blood corpuscles.

Two of the cases, Healy and Spiers, in Group I, were passing only cysts of *E. histolytica* and amœbæ without included red blood corpuscles when first seen, but both of these cases were just recovering from attacks of acute amœbic dysentery which they had had repeatedly for some years. They were really in a transition stage between the condition of the carrier and acute amœbic dysentery. In this group there were fifty-eight cases, of which six were acute cases of amœbic dysentery. Of the 52 carrier cases 37 were cured (C. R.), and did not relapse in the period of control, 10 relapsed (R.), while in 5 the infection did not even disappear, there being apparently no reaction to the treatment (N. R.). The six acute cases all relapsed. It is interesting to note that of the carriers who relapsed only one gave a previous history of dysentery, while three of the five cases which did not react had had previous dysentery. Of the thirty-seven carriers which were cured fifteen gave a history of dysentery. Two of the acute cases gave no history of dysentery, the attack in each case being a primary one.

The results are shown as follows:—

Carrier cases cured	37
,, ,, relapsed	10
,, ,, no reaction	5
Acute cases cured	0
,, ,, relapsed	6
,, ,, no reaction	0

Five of the carrier cases which relapsed, one of those which did not react to the emetin injections (Table X[5]) and one of the acute cases (Rushworth), were cured later by a combined course of emetin injections and emetin by the mouth (Group III); while another two of the carriers who did not react to the emetin injections were cured by a simple course of emetin by the mouth (Spiers and Bennett.)

TABLE X.—Emetin Injections One Grain a Day for Twelve Days.

(A)—Carrier Cases not showing any Amœbæ, with included Red Blood Corpuscles.

Name	A	B	C	D	F	G	Other infections: Before end of emetin course	Other infections: After end of emetin course
Mounsey[1]	++	CR	8	30	+	+	Tet.	E.c., Tet.
Smith, H.[2]	++	CR	4	30	+	+	E.c.	E.c.
Ure	+++	CR	3	35	+	+	—	—
Morgan, S.	+	CR	5	30	+	—	E.c., L., Trich.	E.c., Trich.
Hancock	++	CR	4	35	+	+	—	—
Thompson	+++	CR	4	34	+	—	E.c., L., Tet.	E.c., L., Tet.
Jones	+++	CR	1	32	+	—	E.c.	E.c.
Wynne	+++	CR	6	34	+	—	Tet.	—
Osgood	+	CR	1	25	+	—	E.c., Tet., E.n.	Tet., E.n.
Turnbull	++	CR	3	32	+	+	E.c., Tet.	E.c., Tet.
Burroughs	++	CR	4	30	+	—	E.c.	E.c.
Morris	++	CR	11	39	+	—	E.c., E.n., W.	E.c., E.n., Tet., W.
Wood[3]	+++	CR	2	27	+	—	E.n., Trich.	E.c., Trich.
Harris[11]	+	CR	13	29	+	+	E.c.	E.c., Tet., Trich.
Russell, F.	+++	CR	2	31	+	—	—	E.n.
Walker	+++	CR	2	10	—	—	E.c.	E.c.
Myers	++	CR	2	30	—	—	E.c., Tet., Trich.	E.c., Tet., Trich., T.c.
Pointer	++	CR	7	40	—	—	E.c., E.n., Trich.	E.c., E.n., Trich.
Harding	+	CR	?	32	—	—	E.c.	E.c.
Webb..	+	CR	?	36	—	—	E.c.	E.c.
Cox	++	CR	3	32	—	—	Tet.	E.c., E.n., Tet.
Bowers	++	CR	7	30	—	—	E.c.	E.c.
Noon	++	CR	2	31	—	—	—	E.c.
Turner	+	CR	8	27	—	—	L.	—
Nicholson	+++	CR	8	30	—	—	—	E.c.
Page	++	CR	7	31	—	—	L.	E.c.
Beardwood	++	CR	2	28	—	—	E.c.	E.c.
Inkpan	+	CR	3	38	—	—	Trich.	—
Southgate	+	CR	1	35	—	—	—	E.c.
Nixon..	+	CR	5	36	—	—	E.c., E.n.	E.c.
Neale..	+	CR	2	31	—	—	Trich.	Trich.
Flynn..	+++	CR	9	31	—	—	E.c., E.n.	E.c., E.n.
Kitson	+++	CR	2	32	—	—	E.c.	E.c., E.n.
Knight	++	CR	1	30	—	—	—	—
Ormrod	+++	CR	2	32	—	—	E.c.	E.c.
Cooper	+++	CR	1	35	—	—	E.c.	E.c., E.n.
Badham[4]	++	CR	3	50	—	—	E.c.	E.c.
Webber[5]	+++	R	9	1	+	+	E.c., Coc.	E.c., E.n., Coc.
Pero[5]	+	R	5	7	—	—	E.c., Tet., Trich.	Tet. Trich.
McQuade[5]	++	R	2	22	—	—	Tet.	Tet.
Squires[5]	+++	R	1	10	—	—	E.c., E.n., L.	E.c., E.n., Tet.
Boyd[5]..	+++	R	10	8	—	—	Tet.	E.c., L., Tet., T.c.
Allen[6]..	++	R	2	12	—	—	E.c.	E.c.
Cox, A.[6]	+++	R	6	24	—	—	E.c.	E.c., E.n., Trich.
Jackson, A.[6 11] ..	+	R	3	15	—	—	Tet.	Tet.
Main[6 11]	++	R	2	8	—	—	Trich.	Trich., E.c.
Ealdon[6]	++	R	5	11	—	—	—	E.c.
Spiers[7]	+++	NR	—	—	+	+	—	—
Healy[12]	+++	NR	—	—	+	+	—	—
Kettlewell[7]	+++	NR	—	—	—	—	E.c., Tet.	E.c., Tet.
Bennett[8]	++	NR	—	—	—	—	E.c.	E.c., Trich.
Obbard[5]	++	NR	—	—	—	—	E.c.	E.c.

TABLE X.—*continued.*

(B)—Acute Cases showing Amœbæ with included Red Blood Corpuscles.

Name	A	B	C	D	F	G	Other infections	
							Before end of emetin course	After end of emetin course
Dorter[9]	+++	R	1	7	+	+	—	E.c.
Ball[6 11]	++	R	7	24	+	+	Tet., Trich.	Tet., Trich., T.c.
Barrie[6 11]	+++	R	9	5	+	+	Tet.	E.c., Tet.
Smith, C.[9]	+++	R	1	7	+	+	—	E.c., Tet.
Rushforth[9]	++	R	1	12	—	—	E.c.	E.c., E.n., L.
Gaskin[10]	+	R	2	9	—	—	E.c.	E.c.

[1] When course of emetin injections was completed patient was given emetin ½ grain by the mouth for seven days.

[2] Was given later a twelve days course of emetin one grain a day by the mouth to try and get rid of the *Entamœba coli* infection.

[3] Had a grain of emetin by the mouth on the two nights before the injection course was started.

[4] Had relapsed after eight injections of emetin three weeks before.

[5] Cured later by emetin one grain injection with ½ grain by the mouth each day for twelve days.

[6] Not treated further.

[7] Cured by course of emetin by mouth given immediately afterwards (5½ grains).

[8] Cured later by courses of one grain of emetin by mouth for twelve days.

[9] Relapsed again later after course of emetin by mouth with injections.

[10] Had relapses after emetin ½ grain a day for twelve days.

[11] Had resisted courses of emetin by mouth one grain a day for twelve days.

[12] Afterwards found resistant to 1½ grains of emetin by mouth for twelve days, ipecac. and thymol.

A = Degree or size of infection. B = Result. C = Number of days after commencement of treatment before infection disappeared. D = Number of days of control before cure or relapse was noted. F = History of previous dysentery. G = History of previous emetin treatment. CR = Cure. R = Relapse. NR = No reaction.

Group II.—Cases treated by a Twelve-day Course of One Grain of Emetin orally administered. Table XI.

As there had been a certain number of failures in the treatment by emetin injections in Group I it was decided to try a course of emetin by the mouth for twelve days. We were influenced in this direction by the remarkable result obtained in one case, Spiers, who had a long history of dysentery of three years, who had thirteen separate courses of emetin at one time or another and who had proved refractory to a course of emetin injections of one grain a day for twelve days (see Table X). This case with an enormous infection was given emetin by the mouth one grain a day for two days followed by ½ grain a day for seven days. This treatment brought about an immediate and permanent cure (see history of case, Section I). In the series of cases treated in this way emetin

was administered as a tinct. opii mixture as recommended by certain French physicians. The emetin, one grain, is dissolved in tinct. opii fifteen minims, and the fifteen-minim dose given in a cup of tea, preferably at night just before the patient goes to sleep. Having compared this method of administration with that of emetin in keratin-coated tabloids, we have found that it is much more difficult for the patients to retain the tea mixture without vomiting than the keratin-coated tabloids which we used extensively in a later series of cases. The latter, it is true, also often cause vomiting, but this occurs later when the emetin tabloid has probably passed into the intestine.

In this group there were treated twelve cases, nine of which were carriers, and three acute amœbic dysenterics showing amœbæ with included red blood corpuscles. Of the nine carriers six were cured and half of these gave a history of previous dysentery. Two of the carriers relapsed and one did not react to the treatment. Of the three acute cases two relapsed and one did not react to treatment. The acute cases all had histories of previous dysentery and emetin treatment.

The results are as follows :—

Carrier cases cured	6
,, ,, relapsed	2
,, ,, no reaction	1
Acute cases cured	0
,, ,, relapsed..	2
,, ,, no reaction	1

In this series one of the acute cases (Blair) received the emetin in keratin-coated tabloid instead of the tinct. opii tea mixture. This particular case (Blair) had been treated immediately before with methyl emetin sulphate two grains a day (one-grain injection and one grain by the mouth) for twelve days without any disappearance of the amœbæ.

In addition to the cases just mentioned, there were four others which were treated in a different manner, though still by means of emetin orally administered.

(1) Case Gaskin was given ½ grain of emetin a day by the mouth in the tinct. opii tea mixture for twelve days. The case was one of acute amœbic dysentery showing amœbæ with included red blood corpuscles. There was no history of previous dysentery. The case relapsed nine days after treatment was completed.

(2) Case Spiers was given one grain of emetin in keratin-coated tabloids by the mouth each day for two days followed by half this

TABLE XI.—CASES TREATED BY EMETIN BY THE MOUTH, ONE GRAIN A DAY FOR TWELVE DAYS.

(A) Carrier Cases not showing any Amœbæ with included Red Blood Corpuscles.

Name	A	B	C	D	E	F	G	Other infections before end of emetin course	Other infections after end of emetin course
Bennett[3] ..	++	CR	2	31	–	–	–	E.c.	E.c., Trich.
Duncan ..	+	CR	1	30	1	–	–	E.c., Tet.	E.c., Tet.
Lingard ..	+	CR	3	32	3	–	–	E.c., L., Tet.	E.c., L., Tet.
McGinty ..	++	CR	2	32	1	+	–	E.c., L.	E.c., L., Tet.
Howarth ..	+++	CR	2	36	–	+	+	–	E.c.
Dewhurst ..	++	CR	3	41	10	+	–	E.c.	E.c.
Jackson, A.[1] ..	++	R	10	3	4	–	–	Tet.	Tet.
Harris[2]	++	R	3	7	–	+	+	Ec., Trich.	Ec., Trich., Tet.
Main[1]	++	NR	–	–	1	–	–	Trich.	E.c., Trich.
(B) Acute Cases showing Amœbæ with included Red Blood Corpuscles.									
Ball[1]	+++	R	1	11	1	+	+	Tet., Trich.	Tet., Trich.
Barrie[1] ..	++	NR	–	–	–	+	+	–	E.c., Tet.
Blair	+++	R	4	14	3	+	+	–	E.c.
CASE TREATED BY EMETIN BY THE MOUTH, ½ GRAIN A DAY FOR TWELVE DAYS.									
Gaskin[1] ..	+	R	2	9	1	–	–	E.c.	E.c.
CASE TREATED BY EMETIN BY THE MOUTH, 1½ GRAINS FOR FOUR DAYS AND ONE GRAIN FOR EIGHT DAYS.									
Kettlewell[3] ..	+++	CR	3	32	2	+	+	E.c., Tet.	E.c., Tet.
CASE TREATED BY EMETIN BY THE MOUTH, ONE GRAIN FOR TWO DAYS AND ½ GRAIN FOR SEVEN DAYS.									
Spiers[3]	+++	CR	1	32	2	+	+	–	–
CASE TREATED BY EMETIN BY MOUTH, ½ GRAIN FOR FOUR DAYS AND ONE GRAIN FOR SIX DAYS.									
Healy[3]	+++	NR	–	–	–	+	+	–	–
CASE TREATED BY EMETIN, 1½ GRAINS BY MOUTH FOR TWELVE DAYS.									
Healy[4]	+++	R	4	3	1	+	+	–	–

[1] These cases were given later emetin injections, one grain for twelve days, and again relapsed.
[2] This case was given later emetin injections, one grain a day for twelve days, and was cured.
[3] These cases had already been given emetin injections, one grain a day for twelve days, without reaction immediately before this course.
[4] This case was receiving the second course of emetin by the mouth. Between the two courses there had been a complete course of ipecacuanha combined at the end with some emetin injections and a course of thymol, ten grains t d.s., without result.

A = Degree or size of infection. B = Result. C = Number of days after commencement of treatment before infection disappeared. D = Number of days of control before cure or relapse was noted. E = Number of occasions patient vomited after emetin. F = History of previous dysentery. G = History of previous emetin treatment. CR = Cure. R = Relapse. NR = No reaction.

dose for seven days. This course was commenced immediately on the completion of a twelve-day course of one-grain injections which had not caused a disappearance of the infection. In this case the cure was permanent.

(3) Case Healy, who had failed to react to a twelve-day course of one-grain emetin injections, was given emetin ½ grain a day in tinct. opii tea mixture for four days, followed by twice this dose for six days. This had no effect on the infection.

(4) Case Healy again was given emetin by the mouth after an interval during which he was treated with ipecacuanha and thymol. On this occasion, he was placed on very strict dysentery diet and given by the mouth 1½ grains of emetin a day for twelve days. The infection disappeared, but returned in three days after the course was completed.

(5) Case Kettlewell, who had not reacted to a twelve-day course of one-grain emetin injections, was given emetin by the mouth in a dose of 1½ grains a day for four days followed by one grain a day for eight days. During the treatment the patient was kept in bed on dysentery diet. The infection disappeared and did not recur.

Group III.—Cases treated by Emetin administered both hypodermically and orally (1½ Grains a day for Twelve Days). Table XII.

The cases in this group were all treated on a combined oral and injection therapy. They were kept strictly in bed and given milk or beef tea diet and received each morning during twelve days a one-grain emetin injection and each evening ½ grain of emetin in keratin-coated tabloid by the mouth. The vomiting in these cases was, as a rule, less frequent than when the emetin was given in the tinct. opii tea mixture, and when it occurred it was generally an hour or more after the tabloid had been taken. In this manner were treated thirty-eight cases, of which thirty were simple carriers without dysentery, and eight were acute cases of amœbic dysentery showing active amœbæ with included red blood corpuscles. It will be seen that a cure was obtained in all the carrier cases, though six of these (Table X[5]) had previously relapsed after a course of emetin injections of one grain a day for twelve days. Of the eight acute cases there were five relapses and two cures, while one case (Jackson) was not sufficiently controlled after treatment (only nine days). Two of the acute cases which relapsed (Dorter and Smith) and one which was cured (Rushforth)

TABLE XII.—CASES TREATED BY 1½ GRAINS OF EMETIN FOR TWELVE DAYS. ONE-GRAIN INJECTION EACH MORNING AND ½ GRAIN IN KERATIN-COATED TABLOID BY THE MOUTH EACH NIGHT.

(A) Carrier Cases not showing any Amœbæ with included Red Blood Corpuscles.

Name	A	B	C	D	E	F	G	H	Other Infections	
									Before end of emetin course	After end of emetin course
Weber[1]	++	CR	2	40	1	+	+	10	E.c., Coc.	E.c., E.n.
Jordan	+	CR	2	28	–	+	–	–	E.c., L., E.n.	E.c., L.
Morgan, H. ..	+++	?	10	9	2	+	+	–	Tet.	Tet.
Lyall	+++	CR	2	41	–	–	–	–	E.n.	–
Borg	+	CR	3	33	–	–	–	–	E.c., E.n.	E.c.
Palmer	++	CR	1	34	–	–	–	–	E.c., L., Tet.	E.c., Tet.
English.. ..	++	CR	1	33	6	–	–	–	E.c., E.n.	E.n.
Howard.. ..	+	CR	1	31	–	–	–	–	E.c., Tet., Tric.	E.c., Tet. Trich.
Taylor	+	CR	5	34	1	–	–	–	L.	–
Hyde	++	CR	1	40	4	–	–	–	E.n., Trich.	E.n., Tet., Trich.
Eastdown ..	+++	CR	2	34	–	–	–	–	E.c.	E.c.
Cherril	+++	CR	3	32	1	–	–	–	E.c., E.n., L.	E.c., E.n.
Liddle	+++	CR	1	35	–	–	–	–	E.c. E.n., Trich.	–
Morgan, B. ..	++	CR	1	51	7	–	–	–	—	–
Wing	+	CR	?	47	1	–	–	–	E.c., E.n., L.	E.c., E.n.,L., Tet.
Sargeant ..	+	CR	3	32	2	–	–	–	E.c., E.n., L., Tet.	E.c., E.n., Tet.
Baker	++	CR	?	32	1	–	–	–	—	E.c., L.
Graham.. ..	+++	CR	3	32	–	–	–	–	E.c., E.n.	E.n., Tet.
Reedie	+	CR	2	35	6	–	–	–	T.c.	–
Ross	+	CR	1	31	–	–	–	–	T.c.	–
Obbard[1] ..	++	CR	1	48	3	–	–	10	E.c.	E.c.
Pero[1] [2]	+++	CR	2	30	6	–	–	10	Tet.	Tet.
McQuade[1] ..	+++	CR	1	31	–	–	–	26	Tet.	–
Squires[1].. ..	++	CR	2	32	–	–	–	16	E.c., E.n. T.c.	E.c., E.n.
Boyd[1]	++	CR	3	32	–	–	–	17	E.c., Tet., T.c.	E.c., Tet.
Carr	+++	CR	1	36	–	–	–	–	E.n.	–
Miller	+++	CR	3	36	1	–	–	–	—	–
Downs	+++	CR	2	36	–	–	–	–	E.c.	E.c.
Triphook ..	+	CR	2	34	–	–	–	–	—	–
Lloyd	+++	CR	5	29	2	–	–	–	E.c.	E.c., L.
(B) Acute Cases showing Active Amœbæ with included Red Blood Corpuscles.										
Hollow	+++	CR	2	36	1	+	+	–	Trich.	Trich.
Rushforth[1] ..	++	CR	2	57	1	–	–	18	E.c., E.n.	E.c., E.n.
Russell, H. ..	+++	R	1	3	–	+	+	–	–	–
Dorter[1]	++	R	1	11	–	+	+	9	E.c.	E.c.
Smith[1]	+++	R	–	6	–	+	+	34	E.c., Tet.	Tet.
Greenwood ..	+++	R	12	14	1	+	–	–	–	–
Jackson.. ..	+++	?	2	9	1	+	–	–	L.	L.
Wilkinson ..	+	R	–	23	1	–	–	–	E.c., Tet.	E.c., Tet.

[1] These cases had relapsed after or failed to react to a previous twelve-day course of emetin (one grain a day injection).

[2] Owing to persistent vomiting the ½ grain tabloid of emetin was not given after the sixth day.

A = Degree or size of infection. B = Result. C = Number of days after commencement of treatment before infection disappeared. D = Number of days of control before cure or relapse was noted. E = Number of occasions patient vomited after emetin. F = History of previous dysentery. G = History of previous emetin treatment. H = Interval in days between the termination of a previous course of emetin (one grain a day injection) and the commencement of the present course, both courses during the present observation. CR = Cure. R = Relapse. NR = No reaction.

had already relapsed after treatment by emetin injections of one grain a day for twelve days (Table X). The results are as follows:—

Carrier cases cured	.. ..	30
,, ,, relapsed	.. .. ..	0
,, ,, no reaction	.. .. ..	0
Acute cases cured	.. ..	2
,, ,, relapsed	.. .. ..	5
,, ,, no reaction	.. .. ..	0

(*b*) *Treatment by Methyl Emetin Sulphate.*—Methyl emetin in the form of the sulphate was tried on four cases. This drug prepared by Dr. Pyman of the Wellcome Bureau of Scientific Research is a stable compound which is soluble in water and not decomposed by boiling. As methyl emetin, according to experiments made by one of us (C. M. W. 1915), is equal in amœbicidal power to the emetin hydrochloride, and as it is much less toxic to animals on injection, it was decided to give the drug a trial in amœbic affections in man. Dr. Low had previously tried another salt of methyl emetin on a case of rather doubtful nature at the Albert Dock Hospital, but the investigation was not carried very far and no attempt was made to test its action in comparison with the usually employed emetin hydrochloride.

We have tested methyl emetin sulphate on four cases. Three of these were acute cases of amœbic dysentery, while one was a carrier. The carrier case (Percival) had a +++ infection of *E. histolytica* and a smaller *E. coli* infection. The patient was given for twelve days an injection of the drug each morning (one grain in one cubic centimetre of distilled water) and one grain in keratin-coated tabloids by the mouth each night. The *E. histolytica* infection disappeared after the seventh day of treatment and did not recur during a subsequent control of over one month. During the treatment the patient was kept in bed on milk diet.

Of the acute cases one (Smith) had already relapsed after two courses of emetin hydrochloride (Tables X and XII). He was given the same treatment as the preceding case. The course of methyl emetin apparently had no action on the infection, for free forms of *E. histolytica*, sometimes with included red blood corpuscles, were passed during the whole course. The second acute case treated was Russell—who had also relapsed after a course of emetin hydrochloride (1½ grains a day subcutaneously and orally: Table XII). The same treatment with methyl emetin sulphate as was used in the other cases was adopted. On

this occasion the infection disappeared after the fourth day of treatment but reappeared three days after the completion of the course. The third acute case (Blair) was given the same dose, but it did not even bring about a disappearance of the infection. Accordingly at the end of the twelve-day course of methyl emetin sulphate the treatment was changed to one grain of emetin hydrochloride in keratin-coated tabloid at night. This alteration of the emetin was made without the patient's knowledge. The result was that for the first three nights vomiting occurred within a short time of taking the drug, though there had been no vomiting previously. This illustrates very clearly the difference as regards the property of producing nausea and vomiting between the two drugs, methyl emetin sulphate and emetin hydrochloride.

From the results it seems clear that with acute cases the methyl emetin in the dose employed has not the same power of ridding an individual of infection as the emetin hydrochloride. In two of the cases the infection did not even disappear, while in the third it vanished only to return soon after the completion of the course. It must be remembered that the dose employed (two grains a day) was larger than the largest dose of emetin hydrochloride used by us ($1\frac{1}{2}$ grains a day). The single carrier case, however, cleared up, and no relapse occurred, so that it is clear the drug has an action on the parasite but is not as potent as the usually employed hydrochloride of emetin. It is possible that in larger doses a better result could be obtained. An important feature of the drug is that the nausea and vomiting which so often follow the oral administration of emetin hydrochloride are absent. The patients who had taken the emetin hydrochloride by mouth and who had experienced the nausea following it, stated that they could go on taking the methyl emetin quite easily, and this when double the dose was being given.

It may be stated safely, therefore, that methyl emetin sulphate has not such a marked action on *E. histolytica* as emetin hydrochloride, but that it causes much less vomiting and feeling of nausea than the latter drug.

(*c*) *Treatment by Thymol.*—Owing to a view which had been expressed that thymol as an intestinal disinfectant was a very powerful agent this drug was tried in one case. This was Healy, who had a very large infection of *E. histolytica* (cysts and free forms), and who had resisted a course of one-grain emetin injections, a course of emetin by the mouth and a course of pulv. ipecac. Thymol, ten grains three times a day, was given, but it was absolutely without action on the infection.

(*d*) *Treatment by Pulv. Ipecac.*—The same case, Healy, after having resisted the course of emetin injections and emetin orally, was placed on a course of pulv. ipecac. He was given to start with thirty grains a day, and this was reduced by five grains daily, till a dose of ten grains was reached. This dose was then kept up for eight days, and for the last three days an injection of $\frac{1}{2}$ grain of emetin was given also. The treatment merely had the effect of temporarily diminishing the infection.

General Considerations as regards Treatment.

(*a*) *Is the Object of Treatment to destroy the Cysts or the Amœbæ or both?*—In the treatment of cases of *E. histolytica* infections there is often supposed to be a difference between the carrier case passing cysts and amœbæ in a comparatively normal stool and the acute case passing only amœbæ in the dysenteric stool. The idea has arisen from the notion that the cysts are more resistant than the unprotected amœbæ. It is a fact that the cysts are more resistant, but this has really no bearing on the question of the treatment. As has been explained above there is no real difference between the carrier and the acute case, the two conditions being merely different stages of the same disease. The cysts of *E. histolytica* are formed by amœbæ which are living about the ulcers in the large intestine, and when once a cyst has been produced it has no more influence on the course of the infection. A cyst cannot rupture and liberate its amœbæ in the large intestine. For this to happen it has to find its way to the small intestine where it can come under the action of the pancreatic fluid, and this it cannot do unless it escapes from the intestine and is ingested by another or the same host. This being the case it would probably be a very good thing for an infected individual if all the amœbæ in the intestine could be induced to encyst, for they would then have no course open to them but to pass out in the fæces.

In treating cases of *E. histolytica* infection it is fortunately not the resistant cysts we have to deal with, but the free amœbæ which must be present in the gut if the cysts are found in the stool. The cysts in fact are very useful guides as an indication of the extent of the amœbic infection of the gut in just the same way as the number of ankylostoma eggs is an indication of the number of worms present in the small intestine. In treating an ankylostome infection one does not endeavour to destroy the eggs in the intestine any more than in treating an *E. histolytica* infection one tries

to destroy the cysts. In both cases, the eggs and the cysts are conveniently searched for in the stool to estimate the effect of any course of treatment aimed at the destruction of the worms and the amœbæ respectively. We have dwelt upon this point because we have so often heard it stated that some cases of *E. histolytica* infection will not respond to treatment, merely because the resistant cysts are present in the gut. This view is entirely disproved from the results we have obtained by emetin treatment, and one of these cases (Smith) who relapsed repeatedly never passed cysts at any time during a long observation. The destruction of the cysts is an important matter after they have left the body, for if they are not destroyed they are likely to be carried about by water and flies and give rise to infection in other people. For this reason the stools of dysentery carriers should be disinfected with cresol 1 in 10, and care should be taken that the cysts are not disseminated on the hands or in any other way.

(*b*) *Comparison of the Different Methods of Emetin Treatment.*—The results obtained in the three groups of cases described above can be tabulated as follows. In each group the course of treatment extended over twelve days:—

	Emetin one grain a day injection	Emetin one grain a day by the mouth	Emetin one grain a day injection; ½ grain a day by the mouth
Carrier cases cured	37	6	30
,, ,, relapsed	10	2	0
,, ,, no reaction	5	1	0
Acute cases cured	0	0	2
,, ,, relapsed	6	2	5
,, ,, no reaction	0	1	0

As regards the first two groups the results with the carriers are almost identical, as can be seen by multiplying the smaller figures in Group II by six. There is, however, a slight balance in favour of the one-grain injection over the one grain by the mouth. As regards the acute cases it will be seen that all the cases relapsed, though the balance is again in favour of the injection method of treatment, as one of the cases treated by the mouth showed no reaction.

When we come to the combined treatment (emetin injections one grain a day and emetin by the mouth ½ grain a day) the results are distinctly better both with the carriers and acute cases. With the former there were treated thirty cases and none of those relapsed during the period of control. With the acute cases two were cured and four relapsed. In addition to the combined injection and oral method of emetin administration these cases were

kept in bed on milk or beef-tea diet, and this may have had something to do with the better results, for the cases treated under Groups I and II were not kept in bed and had light chicken diet. The acute cases, however, were all kept in bed on dysentery diet. On the other hand, the cases treated in Group I were given sodium sulphate mixture several times a day, while in Groups II and III the cases were not given the mixture regularly as the emetin administered by the mouth tended to keep the bowels loose, so that the saline mixture was usually unnecessary.

It is important to note that five of the carrier cases which relapsed after treatment in Group I were treated later and cured as in Group III, while one carrier case which did not react at all to the treatment as in Group I was cured later by treatment as in Group II, while case Spiers who resisted the one grain a day by injections was cured by a course of emetin by the mouth immediately after.

It seems to follow from this that certain cases that prove refractory to one line of treatment or one method of emetin administration may respond to emetin administered in another way. It is possibly this factor which has given the better results with the combined method of treatment.

(*c*) *Carrier and Acute Cases.*—It will have been seen from the list given above that the ordinary carrier cases not showing any or only slight symptoms are much more readily cured than the acute cases. Thus all the six acute cases in Group I relapsed after emetin injections of one grain a day for twelve days. In Group II again, where three acute cases were treated by emetin by the mouth (one grain a day), one case did not even react to the treatment, while two relapsed. In the third group there were treated seven acute cases, and of these five relapsed and two were cured.

It is quite evident, therefore, that the cases which are most difficult to rid of infection are not the carrier cases passing cysts without any symptoms, but the acute cases passing blood and mucus in the stool with active amœbæ containing red blood corpuscles. The acute cases have nearly all had a history of recurrent attacks of dysentery and generally previous emetin treatment. Three of these cases, however, were treated at their first attack of dysentery (Rushworth, Wilkinson and Gaskin), yet all of them relapsed. Rushworth, however, was subsequently cured by a course of emetin given by injection and by the mouth (Table XII).

The action of emetin on the carrier case generally causes the

disappearance of cysts from the stool in two or three days, and similarly in the acute cases not only do the amœbæ disappear very quickly but the symptoms clear up also and the patient to all intents and purposes has recovered from his dysentery. It is this fact which had led to the idea that emetin in small doses is such a sure specific for amœbic dysentery. It is only by the detailed control of the cases, as in the methods adopted by us in these observations, that the subsequent course of the cases can be followed. It has resulted that in almost every instance relapse has taken place.

The acute cases seem to differ from the carrier cases only in degree, for between the attacks of dysentery the acute cases are actually in the carrier condition passing amœbæ and cysts which are indistinguishable from those passed by the carriers who have, perhaps, never had an attack of dysentery. The view which has already been expressed above, that it seems probable that all the carriers have some ulceration of the intestine, affords the best explanation of this difference in the action of emetin in the acute and carrier cases. Certain of the carrier cases have no symptoms whatever and it is possible that in them the ulceration is at a minimum. Other carriers have had an attack of dysentery and from time to time pass mucus in the stool. In them the ulceration is probably more extensive. With a still more serious condition of ulceration the attacks of dysentery are more frequent and we get the condition of the typical chronic amœbic dysenteric who has repeated attacks of dysentery. During these he passes blood and mucus with active amœbæ containing red blood cells. Between the attacks the stool is always soft, and contains varying quantities of mucus, while *E. histolytica* cysts and amœbæ are found in enormous numbers. The most serious condition is seen in cases like that of Smith where the dysentery is practically constant and encysted forms of *E. histolytica* never occur in the stool. The amœbæ are always in the free condition and frequently show included red blood corpuscles. These cases with extensive ulceration are naturally much more difficult to treat than the simple carriers who have only very slight intestinal lesions. It seems probable that the varying condition of the gut rather than any other factor is responsible for the variation in the response to emetin treatment. We do not know how the emetin reaches the amœbæ or exactly how it is excreted, for cures have been effected both by hypodermic injection of emetin as well as by emetin by the mouth, but if the drug is usually brought into contact with the amœbæ by way of the circula-

tion then it is perhaps understandable that, in cases with the extensive ulceration of the chronic amœbic dysenteric, with old fibrotic ulcers and thrombosed vessels, the emetin is unable to reach many of the amœbæ for purely mechanical reasons of impaired circulation. It is possible that in this condition the amœbæ in certain situations can be reached and destroyed if emetin is given by the mouth instead of by injection.

(*d*) *Are there Emetin-resistant Strains of Amœbæ ?*—It has been suggested that, in certain cases, the amœbæ owing to past inefficient emetin treatment have acquired the power of resisting the drug. It is very difficult to obtain precise information on this point, for, as already explained, the failure of emetin to cure may be due to purely mechanical reasons of poor circulation or other causes. Case Spiers is of much interest in this connexion. There was a long history of dysentery of three years standing, and there had been in all thirteen courses of emetin, after each of which the patient's symptoms disappeared. The patient himself had also been in the habit of taking one or two ½-grain emetin tabloids for this purpose. Such a case had every chance of developing a resistant strain of amœbæ, and when a twelve-day course of one-grain injections failed entirely to influence the infection we were under the impression that the strain of *E. histolytica* was resistant to emetin. This view was entirely disproved by the fact that a course of emetin by the mouth over nine days (5½ grains in all) completely got rid of the infection without any relapse taking place. In this case at any rate it seemed as if the emetin administered by the mouth reached the amœbæ more readily than the emetin by injections. Again, case Healy, who had a still longer history of chronic amœbic dysentery, failed entirely to react to emetin injections. He failed also to react to small doses of emetin by the mouth and also to a course of treatment by pulv. ipecac. Yet a course of emetin by the mouth 1½ grains a day caused the infection to disappear at least for some days.

It therefore seems to us that because an infection does not appear to respond to treatment by emetin injections it does not follow that this failure is due to the presence of a resistant strain, for if the emetin can be made to reach the amœbæ by some other method of administration in most cases some response or even cure will be the result.

The same failure to respond to emetin injections is seen sometimes in the case of amœbic abscess of the liver. A case of this kind was seen by one of us (C. M. W.) in London last year, where

a draining abscess of the liver continued to discharge active amœbæ though a complete course of emetin injections of a grain a day for twelve days was given. A second case of this kind came under our notice a few months ago. We were controlling a case by examinations of the fæces and liver abscess pus for Captain Redmond, R.A.M.C., who was treating the case. The fæces showed no sign of amœbic infection, while the pus from the abscess contained constantly numbers of *E. histolytica*, and this in spite of the fact that the patient received a full course of emetin injections for twelve days, a course of emetin by the mouth, and in addition, irrigation of the abscess cavity with a solution of emetin. The amœbæ were very active and included many red blood corpuscles, an observation which at once disproves the view expressed by Escomel (*Bull. Soc. Path. Exot.*, October, 1913), that *E. histolytica* will not ingest the red blood corpuscles of a person receiving emetin injections. On one occasion a small quantity of the pus was mixed with a solution of emetin hydrochloride (one grain in one cubic centimetre, or 6·5 per cent solution), and a preparation of the mixture watched under the microscope. The amœbæ, instead of being killed at once, moved about actively in the liquid and only came finally to rest after the expiry of ten minutes. We cannot state the exact strength of the emetin solution in which the amœbæ were moving, but it was many times in excess of the usual 1 in 100,000, which is claimed to kill them at once. Whether these amœbæ were emetin-resistant or not cannot be decided till similar observations are made with amœbæ from abscesses in cases which have not received previous emetin treatment. The case just recorded recovered in the usual way by drainage of the abscess cavity, but there was no evidence to show that the various courses of emetin have had any influence in bringing about this fortunate result. It has been claimed that emetin injections will not only clear up the presuppurative hepatitis of amœbic abscess, but it will sometimes cause an actual unopened abscess to disappear. The case recorded above does not offer any explanation of this, though it is possible that the chances of the emetin reaching the amœbæ in an abscess wall vary just as they do in the gut. Some abscesses may have a good circulation in the surrounding tissues, so that the emetin can reach the amœbæ; while in other abscesses, probably of a long duration, the circulation is poor owing to the occlusion of the blood-vessels by thrombosis, fibrosis or other obstruction.

(*e*) *Does Emetin tend to make the Amœbæ encyst?*—It has been stated that the effect of emetin, especially in inadaquate doses, is

to make the *E. histolytica* encyst and to convert an acute into a carrier case. As a rule a protozoan encysts either because it wishes to protect itself against some adverse influence or for reproductive purposes, so the presence of cysts of *E. histolytica* is looked upon as an indication of some adverse influence acting upon the amœbæ in the gut. It was thought, therefore, that if emetin was given in insufficient doses to kill the amœbæ they would tend to protect themselves by encysting. The encystment of the *E. histolytica* in the intestine is not such a simple matter as might at first sight appear. A case with acute dysentery is passing large entamœbæ quite unlike the encysting generation of small amœbæ, and if emetin is to cause the amœbæ to encyst we must suppose that its first effect is to make the large amœbæ divide rapidly to produce small forms, and that these must take on the characters of the pre-encysting "minuta" forms of *E. histolytica*. This is quite another matter than the supposed quick secretion of a capsule round an amœba, because it is being irritated by small doses of emetin.

We have already seen that the natural course of an amœbic infection is that of the carrier case, and that in a certain percentage of these where the ulceration of the gut is extensive attacks of dysentery manifest themselves from time to time, while, between the attacks, the condition of the carrier is reverted to. In whatever way a person becomes infected with *E. histolytica*, whether by an initial attack of amœbic dysentery or not, the natural tendency is towards the development of the carrier condition. This being the case it is manifestly impossible to regard inadequate emetin treatment as a factor which increases the number of carrier cases, for these cases if left untreated would have become carriers in any case. Moreover, the supposed inadequate treatment would probably have cured a few cases at least, so must have reduced the total number of possible carriers.

It is quite possible that when the "encysting" or "minuta" generation of *E. histolytica* is present in the intestine some adverse influence might suddenly cause an encystment of numbers of these, but before we can decide this point we must understand the normal course of such infections, judged by the appearance in the stools. A person who is in the carrier condition passes both cysts of *E. histolytica* and minuta forms of amœbæ, but these are not passed regularly. On some days cysts alone are passed, while on others the amœbæ are most numerous or alone present. Much depends on the consistency of the stool. In some of the carrier cases treated

by us the emetin course was commenced only when cysts were being passed and the immediate effect has appeared to be the disappearance of the cyst with the passage of free amœbæ. On the other hand the reverse has occurred, while generally in the cases of pure *E. histolytica* infection the cysts have tended to disappear from the stool before the amœbæ. The results we have obtained do not afford any evidence in favour of the view that the emetin causes the amœbæ in the gut to encyst. Nor have we been able to obtain any evidence that the emetin treatment causes any particular form of cyst to appear in the stool. In the examinations for carrier cases we have noted that, though most usually the infections show a majority of cysts with four nuclei, with a smaller number of one and two-nuclear cysts, at times infections are encountered where nearly every cyst present has only one nucleus. This has appeared also in our control of individual cases in hospital, and it seems evident that the forms which actually appear in the stool are dependent on the rate of emptying of the large intestine rather than on any peculiar action treatment may be having on the amœbæ which are there.

(*f*) *Influence of other Infections on the Treatment.*—A glance at the tables of the three main groups of cases treated shows that the majority of cases had some other protozoal infection besides the *E. histolytica*. These coincident infections have been arranged in two columns according as to whether they were discovered before or after the completion of the course of emetin treatment. Many of these only appeared and were detected after several days' observation of the case. Without entering into any details it seems quite clear from the tables that amongst the carriers which were cured there were just as many extra infections, which were just as varied as amongst the carriers which relapsed, so that the presence of flagellates or *E. coli* did not in any way prejudice the case against a successful emetin treatment. Amongst the acute cases again extra infections were the rule, but as practically all the cases relapsed it is not possible to judge if the result was in any way due to their presence. Generally speaking our results seem to indicate that the action of emetin on *E. histolytica* is not affected by the presence of other protozoa, and we can find no evidence in support of the view expressed by Dr. Barlow (*New York Med. Journ.*, 1915), that the cases most difficult to treat are those complicated by flagellate infections. In cases treated with emetin by the mouth it was the rule for all the coincident infections to disappear, but in nearly every instance they reappeared later during the period of control.

If one looks at the protocols of the cases treated by the combined method of orally and subcutaneously administered emetin it will be seen how all the infections disappear soon after treatment is commenced. This is illustrated by the occurrence of a complete blank on the charts corresponding to the course of emetin. After the course is completed the columns begin to fill up as the infections reappear.

(*g*) *Influence of Diet and Rest in Bed on the Treatment.*—It has already been explained that the carrier cases appearing in Tables X and XI were given a chicken diet, and were not kept in bed during treatment. The acute cases in these two groups were, however, given dysentery diet and kept in bed. It is difficult to state whether there would have been fewer relapses amongst the carriers in these groups if rest in bed and special milk diet or dysentery diet had been enforced. Rest in bed and milk diet were ordered for the cases appearing in Table XII, and here all the carrier cases were cured. The difference in the result, however, is more probably due to the extra dose of emetin which the latter received. That very bad cases can be cured without any rest in bed is well illustrated by case Spiers, who had, as already mentioned, a very bad history of dysentery and repeated emetin treatments. He was treated whilst he still carried on his usual office occupation, and confined himself to an ordinary light chicken diet. He received during twelve days an injection of a grain of emetin a day, which did not rid him of the infection. This was followed by a course of emetin (5½ grains) by the mouth which permanently cured the patient. This very satisfactory result was obtained without any special rest or diet. Two other carriers (Cox and Badham) were treated by twelve one-grain emetin injections, while they continued on duty and took full diet. One of these was cured and the other relapsed. Another case (Ball) had already had an attack of acute amœbic dysentery, for which he had been treated in bed by oral administration of emetin. He relapsed into the carrier condition and was then treated while still on duty by twelve daily one-grain emetin injections. He relapsed again after the second course. Thus of the four cases treated out of hospital two were cured and two relapsed. It does not seem advisable, however, to treat patients with emetin while still on duty, though this may have to be done in special cases.

When patients are in hospital, and especially when they are in bed, they do not need a full diet, and for this reason it is sufficient to give them milk or other light diet alone. When emetin is being

taken by the mouth, and possibly comes into contact with the amœbæ by way of the intestinal tract, an overloaded intestine would be a disadvantage in that the available emetin would be reduced. Furthermore, the tendency to vomit would be greater if too much food were taken. This of course does not apply to emetin administered by injection only, as this seems to produce very little, if any, tendency to vomiting. Case Healy, who had proved most refractory to treatment and who had had twelve one-grain injections, a course of emetin (eight grains) by the mouth and a full course of treatment by pulv. ipecac. without his infection disappearing, was finally treated on what was almost a starvation diet. He was kept in bed and given the diet of an acute dysenteric (barley water, arrowroot water, jelly, tea with a little milk and custard). This diet was started two days before a course of emetin (1½ grains a day) by the mouth was commenced, and was continued during the twelve-day course of treatment. The infection disappeared, but three days later there were present as many cysts and amœbæ as before. A second case, Kettlewell, who had resisted the twelve one-grain injections, was treated in a similar manner, but with less emetin (fourteen grains during twelve days). The result in this case was a cure without subsequent relapse. It seems, however, that in most cases where there are no actual dysenteric symptoms such a rigid diet is hardly necessary and may possibly do harm in weakening the patient and rendering him more susceptible to the possible action of emetin on the heart. Case Kettlewell was one of the two cases mentioned below in which some irregularity in the heart's action was noted after treatment. In most instances for carrier cases in bed a milk diet with eggs, bread and butter and milk puddings is quite suitable. Those with actual dysentery with blood and mucus in the stool may require a more rigid diet.

(*h*) *Influence of Salines on the Treatment.*—All the cases in Group I were given a mixture containing sodium sulphate one dram four or more times a day, with a view to flushing out the gut. The cases in the second group were not given the mixture so regularly, while in the third group they seldom had it. As already mentioned, emetin by the mouth itself tends to keep the bowels loose, so that salines are not needed so frequently for this purpose. With the acute cases the bowels are generally quite loose without any salines. From the cases we have treated it does not seem that the salines have influenced the result in any way. In fact, the regular administration of salines does not tend to produce such a constant washing out of the large intestine as is often supposed.

We have noted that patients who take sodium sulphate mixture regularly so many times a day may pass watery stools for the first two days, but that the effect of the saline seems to pass off. A better result would probably be obtained by giving a single large dose of saline each morning. Barlow (*New York Med. Journ.*, October, 1915) has recently expressed the opinion that emetin has a better chance of action on the amœbæ if there is not too much flushing of the gut, and he advocates the administration of a saline every five or six days only to clear out the large intestine.

(*i*) *Effect of Emetin on the Patient. Gastro-Intestinal.*—Emetin administered by the mouth causes vomiting in many instances. In the Tables XI and XII, showing the various groups of cases treated, the number of times each patient vomited, if at all, is shown in a special column (E). This only occurred after emetin orally administered, and the patients did not vomit more than once after any single dose. Emetin injections do not produce vomiting, though some complain of a feeling of nausea. At first the drug was given, as explained above, dissolved in tinct. opii, the requisite dose being taken in a cup of tea at night. This caused vomiting very easily, especially in some cases, so that finally this method was abandoned in favour of emetin in the form of keratin-coated tabloids. Even this caused a good deal of vomiting, but usually it was an hour or more after taking the dose. In the group of cases treated both by injection and orally, one case (Pero) vomited almost at once after each tabloid, so that after six nights the ½-grain tabloid by the mouth had to be discontinued. Vomiting so quickly after the tabloid was, however, the exception. One of the cases (Dewhurst), treated exclusively by emetin by the mouth in the tinct. opii tea mixture, vomited after ten of the twelve doses, as will be seen by the chart of his case. In spite of this the *E. histolytica* infection disappeared and there was no recurrence. Case Spiers, who had resisted twelve injections of emetin, was given emetin by the mouth, one grain in keratin-coated capsule. The dose was taken at night before going to sleep, but though the patient made every effort to prevent this, he vomited on two nights, once after two hours and once after three. Nevertheless, the amœbæ disappeared immediately from the stool, though they were present in enormous numbers before. It is thus evident that though the drug may cause vomiting the bulk of the dose taken is retained. As regards the vomiting after the drug, a great deal depends upon the determination of the patient to withstand the inclination. When several patients in one ward are receiving the treatment it often happens that if one of them vomits the others follow suit at once.

One case (Healy), which proved very resistant to emetin, was given emetin 1½ grains by the mouth for twelve days. There was a strong feeling of nausea, but the patient made heroic efforts and was able to prevent himself from vomiting on every occasion except after the first dose, though this was not till six hours after it was taken.

It seems that a certain resistance to the nauseating effect can be acquired, and though the first two or three doses may be followed by a desire to vomit, the later doses can be taken with impunity. Case Healy, who took the 1½ grains for twelve days, found this most marked, and felt that finally he could have continued without any ill effect in this direction.

Emetin administered by the mouth, as already explained, tends to produce looseness of the bowels, so that if the drug is being administered in this way it is unnecessary to give salines. We have not noted any tendency to diarrhœa as a result of emetin administered subcutaneously alone, nor has the emetin produced any hæmorrhage from the bowel, as it is supposed to do sometimes by causing some change in the vessels about the ulcerated areas.

Local.—The subcutaneous injection of emetin has produced very little local effect. The only cases which have complained of any local trouble have been nervous, highly sensitive individuals who have stated that the injection of emetin was followed by pain at the site of injection. The majority of cases, however, have taken the injections without any complaint. In one case, in which twelve one-grain injections were given into the right arm, the last injection, the only one given in the forearm, produced a tingling in the hand and elbow. It is probable that in this case a nerve was accidentally injured.

General.—In certain cases the emetin seems to produce a feeling of stiffness and weakness in all the limbs and a general lassitude. Case Spiers, who had the twelve-grain course of emetin while he carried on his regular office work, noted this weakness especially in the legs.

Heart.—The possible deleterious action of emetin on the heart is of great importance. It has been reported from time to time that emetin has caused not only derangement of the heart's action but even death in some instances. Dale has noted that in cats there is definite evidence that emetin in large doses is cumulative in its action, so that care has to be exercised in its administration. On this account we have paid very special attention to this point in the treatment of our cases, the pulse rate and temperature having been kept regularly. We can say that in only two instances

were any signs of heart trouble noted. In one case (Kettlewell) there had been given twelve one-grain injections of emetin, and as this had not abolished the infection the patient was placed on dysentery diet, kept in bed and given 1½ grains of emetin by the mouth for four days, followed by one grain for eight days. When he got up after the treatment he felt weak, a condition which must have resulted not only from the emetin he had had, but also from the low diet and stay in bed. He suffered from shortness of breath on exertion, and when he was discharged to a convalescent home this became more marked and was accompanied by irregularity in the action of the heart. The patient was kept at rest as much as possible and in the course of three weeks the condition passed off, when he returned to full duty. Another case which did not react to twelve one-grain injections of emetin was then treated by twelve one-grain injections with ½ grain by the mouth. The patient was kept in bed on a milk diet. Shortness of breath and irregularity of the heart were noted when he got up after treatment. The condition passed off in a couple of weeks.

In none of the other cases treated was anything comparable noted. It seems evident that certain individuals are more easily affected by the drug than others, and it is probable that such have an idiosyncrasy to the drug just as certain individuals have to quinine. In the great majority of cases however emetin produces no such symptoms, and case Healy, who had in all forty-six grains of emetin together with a course of pulv. ipecac. during a period of fifty-three days, was quite immune to the drug from this point of view.

In order therefore to be on the safe side it is better to keep the patient in bed, especially when more than one grain of emetin a day is being administered and when the patient is being kept on the low diet, for this in itself tends to reduce the resisting powers. Furthermore, a patient in bed is under better control as regards his diet, and it is easier to make observations on the temperature and pulse under these conditions. The collection of samples of the stool for examination is also facilitated.

Temperature.—In none of the cases treated did the emetin appear to have any effect on the temperature. In those in which some irregularity was noted during the course of emetin some other factor was present. In one case peculiar unexplained elevations of temperature were found to be due to an appendicitis, and in another case to malaria.

(*j*) *When does the Infection disappear under Emetin Treatment?*—In Tables X, XI and XII, columns (C) are inserted showing

the number of days before infections disappeared after emetin was commenced. In the cases in which there was no reaction (NR) to the emetin treatment there was no disappearance of infection, accordingly a blank is left. In other cases where a ? is inserted the exact day of disappearance of infection is doubtful, either because the infection was temporarily absent at the commencement of treatment or because only free amœbæ were present, which could not be distinguished from *E. coli* which were present also.

Of thirty-five carrier cases which received one grain of emetin subcutaneously for twelve days and which did not relapse, the infection persisted on an average for four days before disappearing, while of ten carrier cases which were treated in the same way and which relapsed later, the figure is 4·5 days. On the other hand, for twenty-seven carrier cases treated and cured by the combined subcutaneous and oral method (1½ grains a day) the average is only two days. Amongst the carriers treated in this way there were no relapses. The cases which were treated by one grain of emetin by the mouth alone occupy an intermediate position.

It is evident that as regards the rapidity of disappearance of the infection the combined treatment gives the best results.

If we take into consideration the degree of infection as shown in the columns in the tables it will be found that for the carriers who did not relapse and who were treated with one-grain injections the +++ infections gave an average time of disappearance of 3·5 days, the ++ infections an average of 4·3 days and the + infection 3·5. With the carrier cases treated by the combined method the figures are 2·3, 1·5, and 2·3 respectively.

It thus appears that the intensity of the infection as judged by the appearances in the stool has very little to do with the rate of disappearance of amœbæ or cysts. It is significant however that the cases which did not react to the injection of one grain of emetin for twelve days all had large infections, and this is true also to a great extent of the cases which were cured but which relapsed later.

As regards the acute cases, in the majority the infection rapidly disappeared in one or two days, but in a few it persisted for a longer period and in one case as long as the last day of treatment. It is important to note that with all the acute cases the clinical signs of dysentery disappeared very rapidly and this in spite of the fact that practically all relapsed later. Most of these acute cases had already been treated with emetin in other hospitals and had been discharged as cured. The remarkable feature of the emetin treatment is not that in some cases, such as Healy with a +++

infection, there should be a failure to bring about a disappearance of the infection, but that in certain cases, such as Carr, for instance, who had a simply overwhelming infection, the largest we have encountered, the first day of treatment was sufficient to abolish it. It has already been mentioned that the cysts which Carr was passing produced a fatal dysentery in two kittens. It must be remembered that Healy had a long history of previous dysentery while Carr had none, and it is probably in this direction that an explanation is to be sought. Presumably the degree of involvement of the large intestine was greater and of much longer standing in Healy than in Carr, and in his case it was probably much more difficult for the emetin to gain access to all the amœbæ, many of which would escape in localities such as the necrotic pieces of tissue and the base of old ulcers where there was little or only a poor circulation.

(*k*) *When do Relapses occur?*—In our series of observations we have taken as a period of control one month after treatment has been completed. The majority of our cases have been controlled beyond this period, during which the stools have been examined as a rule on every alternate day. In this way we have been able to detect a relapse as soon as it has occurred. Where relapse has occurred after treatment this has taken place in under twenty days, except in three cases, two of which were carriers treated by injections of one grain of emetin, and one an acute case. In every instance the relapse was judged, as was the diagnosis in the first place, by the appearance of cysts of *E. histolytica* or amœbæ with included red blood corpuscles. It seems evident therefore that a control of one month after treatment is quite sufficient to ensure that a cure has taken place. Many of our cases have been subjected to an even longer control.

As regards the acute cases it has been pointed out above that the diagnosis of these was made on the occurrence of amœbæ with included red blood corpuscles in a dysenteric stool and that the treatment in all cases caused the rapid disappearance of symptoms, though the infection might not disappear till later. When these cases relapsed, and this has unfortunately happened in the majority of acute cases treated by us, there is not at first a return of the dysentery, but the relapse has been detected by the appearance of cysts of *E. histolytica* in the stool. One such case (Russell) has been mentioned already. The first sign of relapse was the appearance of cysts in the stool and some time after he was readmitted with acute amœbic dysentery again. In the case of Smith the relapses could not be judged by the appearance of cysts, for this

case never passed any, but by the reappearance of amœbæ with included red blood corpuscles.

(*l*) *The Effect of Previous Dysentery on the Treatment.*—We have gone very carefully into the histories of the cases and have obtained information as to previous dysentery. It will be seen by the tables that the majority of carriers gave no history of previous dysentery. Most of them had been on the Peninsula and had had diarrhœa, and those who had had dysentery were, of course, unable to state the kind of dysentery from which they had suffered. Still, the history, whatever it is worth, is set out in Tables X, XI, and XII. Of the thirty-seven carriers treated by one-grain emetin injections and who did not relapse, fifteen gave some history of dysentery, mostly on the Peninsula. Of the ten cases which relapsed, only one had a history of dysentery, while of five who did not react to the treatment two gave a positive history. It seems, therefore, that as far as these carriers are concerned a previous history does not affect the treatment.

When we come to consider the acute cases we find that there was a previous history in every case except three (Rushforth, Wilkinson, and Gaskin), who were suffering from their first attack. These three cases relapsed after a first course of emetin, though a second course was successful in curing one (Rushforth). All the other acute cases gave definite histories of dysentery, generally of repeated attacks. Each had been repeatedly treated in various hospitals with or without emetin. From each place the case had been discharged as cured, but relapse had occurred later on. The histories of these cases are most unfortunate, as the men rarely come back to the same hospital, so that in each instance the same line of emetin treatment is repeated, even if the patient has been fortunate enough to have his condition correctly diagnosed. The danger of emetin in these acute cases is that it produces a false security, for it very quickly abolishes the symptoms without ridding the patient of an infection which can only be detected by expert microscopical examination.

As we have already explained, it seems that the carrier case who has either had no dysentery at all or only a single attack, has a condition of the intestine much more amenable to treatment than that of the case which has repeated attacks of dysentery. The patient whom one sees in the acute dysenteric condition does not differ from the healthy or comparatively healthy carrier, except that he has a more extensive or active ulceration of the large intestine, and if this view is correct it is not surprising that these acute cases are much more difficult to cure than the carriers. In this respect,

therefore, history of previous dysentery (if this has been definitely amœbic) or, more especially, histories of repeated attacks as indicating a more extensive involvement of the large intestine, indicate a bad prognosis as regards emetin treatment.

Exceptions to this rule occur, however, for case Spiers, so frequently referred to in this paper, had a very bad history of recurrent dysentery, yet he was completely cured by emetin.

(*m*) *Effect of Previous Emetin Treatment.*—The possibiilty of previous emetin treatment having produced a resistant or emetin-fast strain of *E. histolytica* has been discussed above. It will be seen from the table of thirty-seven cases treated by one-grain injections (Table X) that six of the carriers who were cured had had previous emetin treatment for dysentery. Of ten that relapsed, only one had had a previous course of emetin. Of five cases which did not react, two had had previous emetin treatment on many occasions, but these (Healy and Spiers), though in a carrier condition when first seen by us, had just recovered from acute attacks and ought rather to be classed with the actual acute cases. Practically all the acute cases had had repeated attacks of dysentery, and this has meant repeated though less numerous courses of emetin. The three acute cases (Rushforth, Wilkinson, and Gaskin) who had had no previous dysentery and consequently no previous emetin treatment, all relapsed after the first course of emetin; Rushforth and Gaskin were given a second course and the former of these was cured. It would appear, therefore, that a previous course of emetin in itself does not affect the subsequent treatment. The symptoms of dysentery cleared up just as quickly in those previously treated as in those who had had no treatment before.

(*n*) *Delayed Action of Emetin.*—When emetin is administered subcutaneously, on its rate of absorption depends its action on the amœbæ. When a course of injections is given, if absorption does not take place very quickly it is evident that the drug will go on acting on the amœbæ for some time after the treatment has been stopped. Thus with case Greenwood amœbæ were still present in large numbers the day after the course of treatment was completed, but they had completely disappeared at the next examination and they remained absent till a relapse occurred some time later. We do not yet know how quickly the emetin is excreted from the body, but a delayed cure like the one just quoted seems to indicate that the emetin may not reach the amœbæ in its maximum concentration till a day or more after injection.

(*o*) *Best Method of Emetin Administration.*—From what has

already been said regarding the cases we have treated it is clear that the best results have been obtained by the employment of the combined method of emetin treatment. This has consisted in the administration of one grain of emetin hydrochloride subcutaneously each morning, and ½ grain in keratin-coated tabloid orally each night, the course of emetin extending over twelve days. During the course the patient should stay in bed and be kept on light diet, which must be a strict dysentery diet if blood and mucus are present in the stool. It is not necessary to give salines regularly, but they must be employed if there is the slightest tendency towards constipation. This treatment has given us the best results. All the carrier cases treated in this way have been cured, and two, possibly three, out of eight acute cases with definite dysentery. This treatment can, therefore, be safely employed for all cases of *E. histolytica* infection, though the results with acute cases, especially those who have had long histories of repeated dysenteric attacks, will be far from satisfactory when compared with the results obtained in the case of a carrier. The treatment has the effect of almost immediately clearing up the dysentery, while the amœbæ disappear from the stool. In most of the acute dysentery cases, however, relapse occurs later. For this reason we feel that it would be well to treat cases of this nature during long periods as one would treat chronic malaria infections. The initial course of emetin as explained above can be given, and this might be followed by a long course of emetin, say $\frac{1}{10}$ grain, or even $\frac{1}{6}$ grain, taken orally in keratin-coated tabloid each night. A tolerance, as regards nausea, would be quickly acquired, and it is very probable that the daily exhibition of the small dose during two or three months after the initial course of emetin would prevent relapse occurring. We have had no opportunity of testing this method, but from what we know of malaria and quinine there seems to be every prospect of success. Such a small dose as $\frac{1}{10}$ or $\frac{1}{8}$ grain, or even ¼ grain, is hardly likely to affect the patient's health, for we know of several cases who have taken much larger doses over long periods without any untoward symptoms developing. We would advise that carrier cases of *E. histolytica* be treated with 1½ grains of emetin as explained above, and that cases with actual dysentery with blood and mucus be treated in the same manner, though with a stricter dysentery diet. If these dysenteric cases show any tendency to relapse, as they frequently do, the emetin course can be repeated and be followed by a long course of emetin by the mouth in small doses as is done with quinine in cases of chronic malaria.

Clinical and other Notes.

CASE OF TERTIAN MALARIA CONTRACTED IN FRANCE, COMBINED WITH TRANSPOSITION OF ABDOMINAL AND THORACIC VISCERA.

By Captain H. A. COOKSON.
Royal Army Medical Corps (Territorial Force).
AND
Captain T. S. ALLEN.
Royal Army Medical Corps.

Pte. X. was admitted to No. —— General Hospital as a stretcher case on March 27, 1916, with temperature 103° F., pulse 104, respiration 28.

He complained of pain in left side of chest posteriorly, and also below right infracostal margin. He stated that he had been ill for eight days, but that he had not felt in good health for some months, having had shivering attacks and feverishness frequently. He had never been out East. He appeared pinched and debilitated.

Examination.

Chest.—No pulsation was noticed in the fifth left intercostal space, but at a corresponding position on the right side; heart sounds were well heard at this point, and were normal. The percussion note was slightly impaired over the base of left lung.

Abdomen.—On the right side a slight fullness was noticed below the right infracostal margin, and a tympanitic note was obtained on percussion up to fifth interspace; there was no hepatic dullness.

On the left side a tympanitic note was obtained, and was continuous from below up to infracostal margin, extending to fourth interspace in parasternal line.

The patient was then X-rayed by Captain Allen, who reported as follows:—

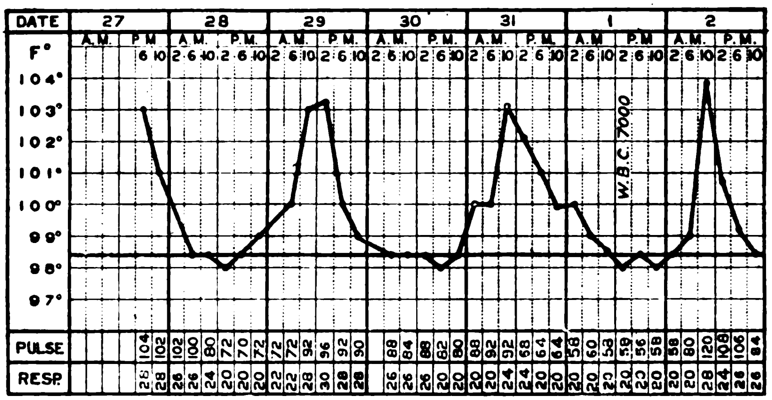
Screen Examination.

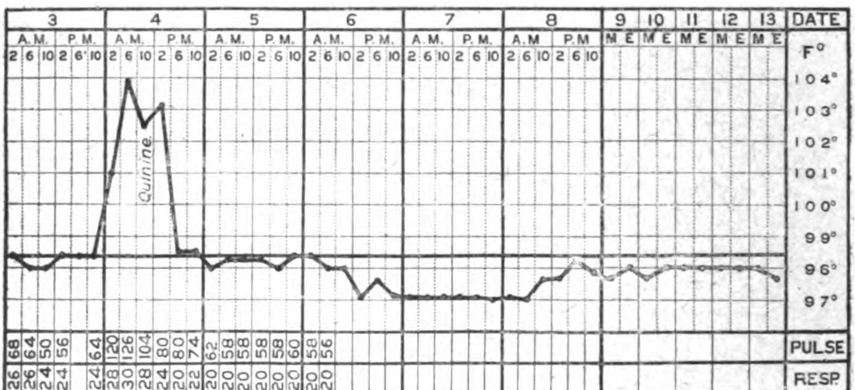
Lungs.—Apices clear, no signs of fluid in either pleural cavity.

Heart.—Normal cardiac shadow absent from left side of chest, and was completely reversed—the apex being directed to the right side of the chest.

Abdomen.—The left dome of the diaphragm was regular in contour, complete opacity extended from it to a point just below the left costal margin and outlining a transposed liver. The right dome of the diaphragm was well defined, and below this was a light translucent area which

corresponded with the presence of air in a right-sided stomach. The patient was given a bolus of bismuth carbonate to swallow, and the passage of the material was readily tracked down the œsophagus with the patient in the left anterior oblique position. The bismuth shadow in the stomach was well seen to the right of the mid-line of the abdomen. Patient was then given a feed containing two ounces of bismuth





carbonate, and exposures were made with patient lying in the prone position with the tube shown.

Plates I and II, taken immediately afterwards, show cardiac shadow in right chest, with the outline of the stomach exposed by the presence of bismuth; the lesser curvature is sharply defined and directed towards the left of the body.

Plate III, exposed twelve hours later, shows the bismuth collecting at the cæcum in the left iliaç region.

The patient's temperature chart (*vide supra*) now attracted attention, and the blood was examined: Red blood corpuscles, 4,500,000; white blood corpuscles, 7,000; hæmoglobin, 70. Red blood cells showed

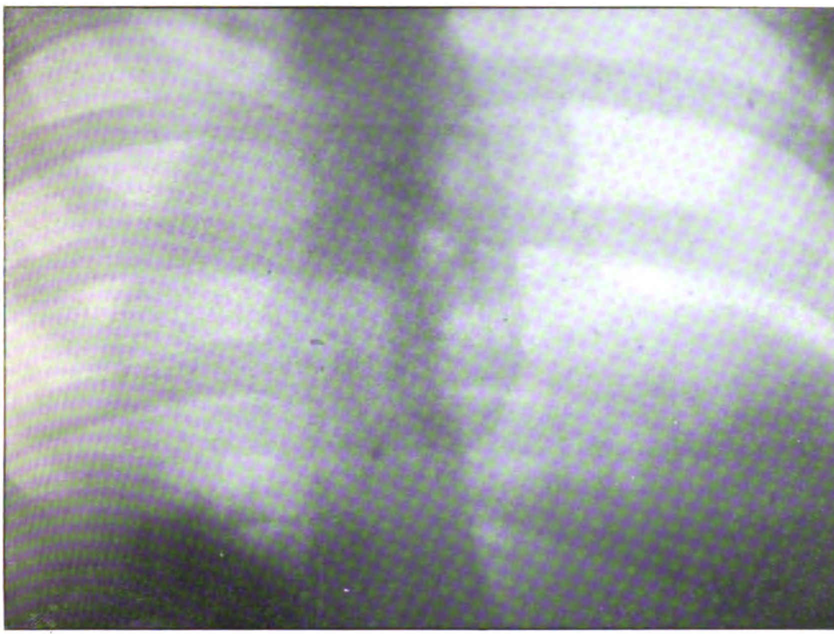


PLATE I.

To illustrate "Case of Tertian Malaria contracted in France, combined with Transposition of Abdominal and Thoracic Viscera," by Captain H. A. Cookson, R.A.M.C. (T.F.), and Captain T. S. Allen, R.A.M.C.

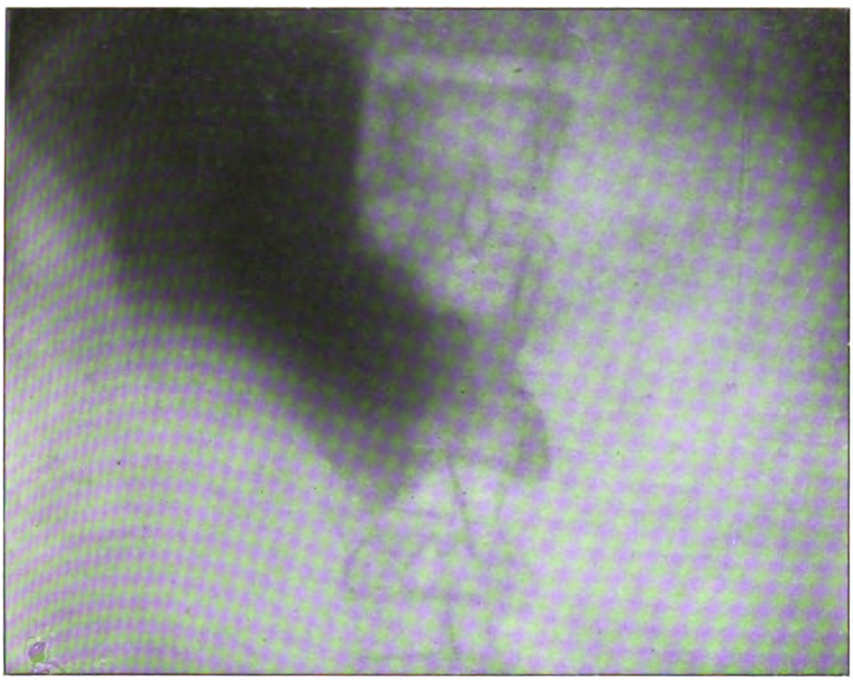


PLATE II.

To illustrate "Case of Tertian Malaria contracted in France, combined with Transposition of Abdominal and Thoracic Viscera," by Captain H. A. COOKSON, R.A.M.C. (T.F.), and Captain T. S. ALLEN, R.A.M.C.

PLATE III.

To illustrate "Case of Tertian Malaria contracted in France, combined with Transposition of Abdominal and Thoracic Viscera," by Captain H. A. COOKSON, R.A.M.C. (T.F.), and Captain T. S. ALLEN, R.A.M.C.

enlargement, poikilocytosis, vacuolation of protoplasm, pigmentation, and presence of the parasite of tertian malaria. The patient was immediately placed on quinine, and thereafter ran a normal temperature.

Conclusion.

In addition to the interesting condition of transposition of the viscera in this case, the specially noteworthy feature was the fact that this man had contracted and exhibited a well-marked condition of tertian malaria, in spite of the fact that he had never, at any time, been further East than in France.

In this connexion it should be added that in April and June, 1915, he had been at X. in Flanders near an Indian Division, and he was at this time much subjected to the bites of "midges" (patient's own word).

NOTE ON THE TREATMENT OF "TRENCH FEET."

By GEORGE COOPER, B.A., M.D.
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The experimental work of Lorrain Smith, Ritchie and Dawson, on rabbits, suggests that in the affection known as trench feet the primary and most serious injury is sustained by the blood-vessels. They found in their experiments that the vessel walls had been seriously damaged, there was swelling of the intima and vacuolation of the cells of the muscle coat; there was also considerable exudate and the establishment of a condition of local stasis and œdema.

A large number of cases of trench feet have come under my care and I have been struck by the fact that nearly all these patients complained of the pain which they endured at night. This symptom, combined with the obvious signs of local vasomotor paralysis, led me to try the effect of affording external support to the relaxed vessels by means of crêpe bandages. In every case, the relief from pain has been striking and immediate, and the progress of cases so treated has been rapid and satisfactory.

The bandages should be applied so as to exert a firm but gentle pressure without causing constriction of the vessels, and as a matter of practice most patients speedily learn to adjust them for themselves. The entire foot should be bandaged, and the toes can best be included by first enclosing them in cotton wool. If small patches of broken or ulcerated skin are present, the bandages can be applied over the ordinary dressing.

The method of treating trench feet by crêpe bandages will be found most valuable in at once alleviating the pain which is so common a feature in this condition, and while directly promoting the absorption of exudates it has the advantage that it need not interfere with any of the usual methods of treatment by massage or electricity.

STIRLING'S WEBBING STRETCHER: A STRETCHER DESIGNED TO FACILITATE THE CARRIAGE OF WOUNDED FROM NARROW TRENCHES.

By Captain R. JOHNSTONE STIRLING.
Royal Army Medical Corps (S.R.).

Description of Stretcher.

The stretcher is constructed of strong broad webbing, and is composed of two sets of braces (A and B) and a body (E). It is operated by two bearers.

Fig. 1.

The Braces.—Each bearer wears a set of braces made in the form of a double loop of "figure of 8." The braces are slipped on as a waistcoat is, thus leaving the chest free of pressure. Attached to the most dependent portions of each brace is a metal hook (C).

Body of Stretcher.—The body of the stretcher (E) is composed of two long lateral and parallel strips of webbing, equal in length, connected (ladder-like) at intervals by shorter pieces, the second piece from No. 2 bearer's end being slightly longer than the others. At both ends of these lateral strips metal D's (F) are attached. These D's are for connecting with the corresponding brace hooks (C). Attached to each D is a short chain (G) for purpose of adjustment. A strap of webbing (H) with a loop at the free end is attached to each lateral strip, near the front, or No. 1 end, for passing round the patient in such a way as to support him in a horizontal position.

FIG. 2.

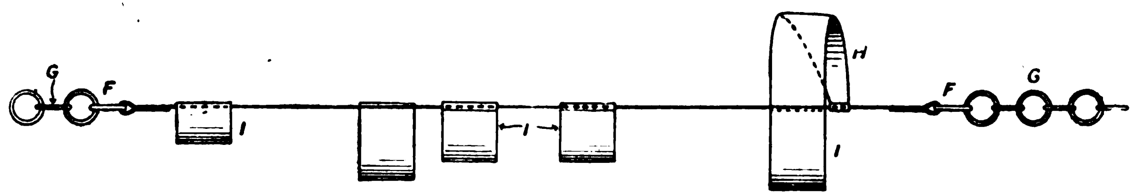
Rigid Stretcher.—On the surface of each lateral strip are several loops (I) for the insertion of a rifle, short pole, or other suitable implement for the formation of a rigid stretcher, when such is required.

Method of Use. Ordinary Sitting Cases.—The bearers, having their respective braces on, pass the body of the stretcher under the patient so that his buttocks are in the space (K) between the first and second cross pieces from the rear, or No. 2 bearer's end; the leg straps (H) are now passed round the legs above the ankles, and, to secure them in position, the front ends of the lateral strips are threaded through the loops of the leg straps, thus providing excellent means of support for the legs. The

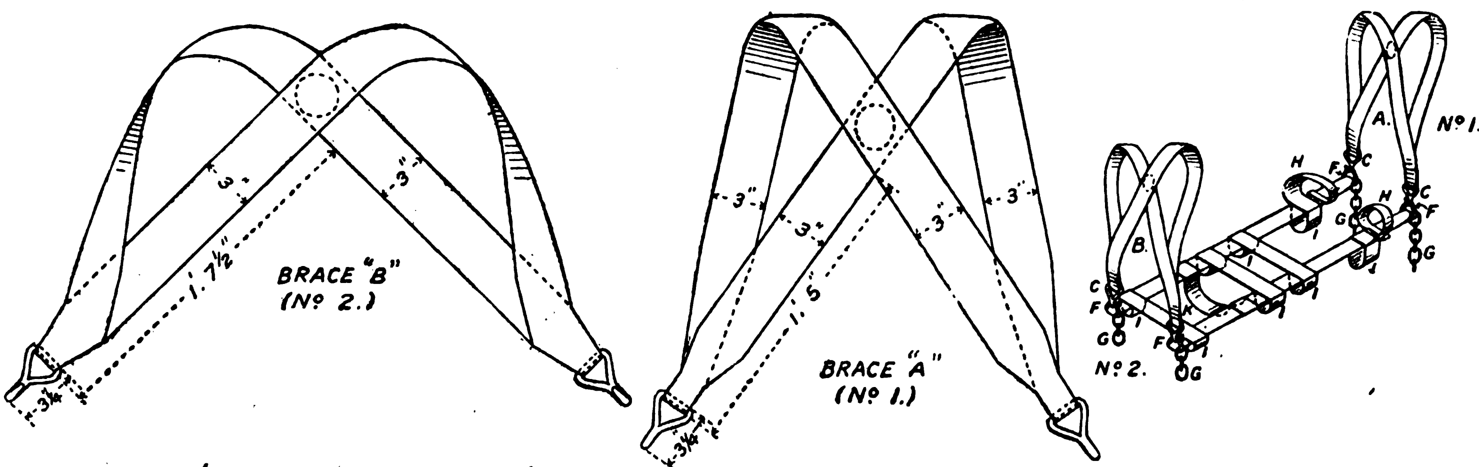
DESIGN FOR PROPOSED STRETCHER.

Reference.

A (No. 1) and B (No. 2) = Braces.	G = Chains.
C = Hooks.	H = Leg Carrier.
E = Body.	I = Loops.
F = D's.	K = Centre of Seat.

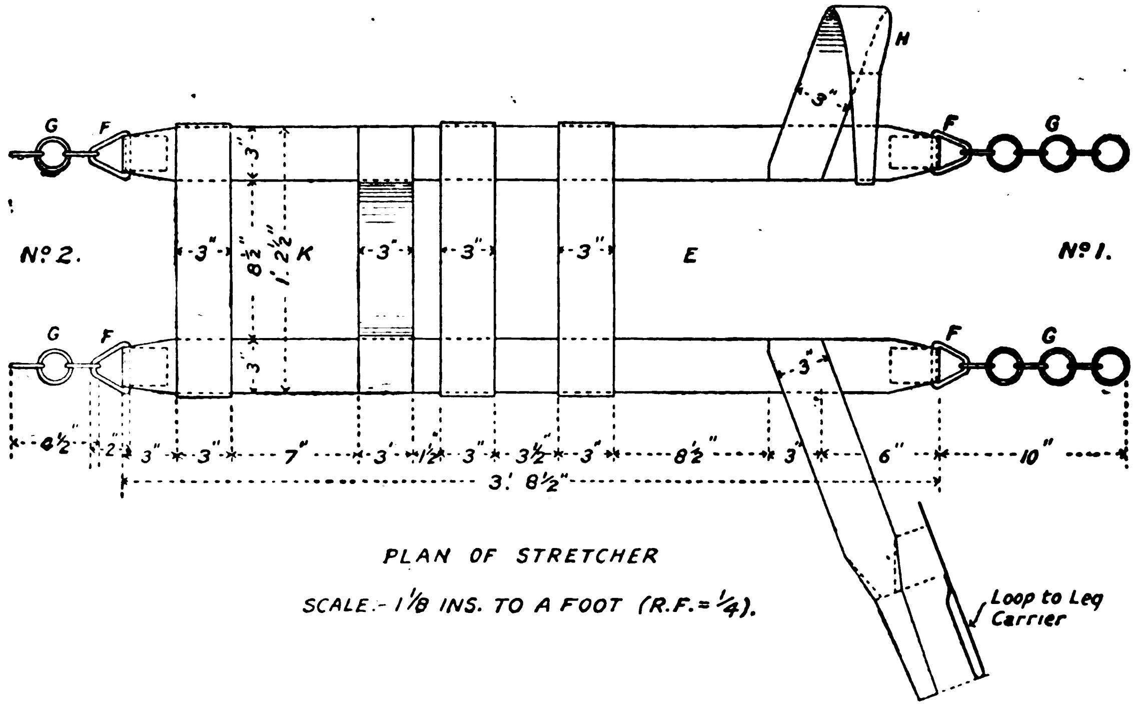


ELEVATION OF STRETCHER



SCALE:-1⅛ INS. TO A FOOT (R.F. = ¼).

SKETCH VIEW OF STRETCHER & BRACES.



PLAN OF STRETCHER

SCALE.- 1⅛ INS. TO A FOOT (R.F. = ¼).

bearers are now ready to lift the patient. No. 1 kneels with his back to, and between the legs of, the patient; No. 2 kneels at the patient's head and facing the back of No. 1. If necessary, No. 2 may first assist No. 1 to hook up. The bearers now connect their brace hooks (C) with the

Fig. 3.

corresponding D's (F) or with the chain links (G) (as circumstances dictate) of the stretcher body (E), which done, leaning forward, they rise together.

Rigid Stretcher—For Lying-down Cases.—For the cases in which it

Fig. 4.

is desirable that the patient lie prone, or on his back, a couple of rifles, or pieces of wood, one on either side, are slipped into the special loops (G) provided for this purpose, the rifle butt at No. 1 end; a rigid but comfortable stretcher is thus provided. For such cases the patient is laid on the body of the stretcher so that his head is level with the rear D's; the leg straps are adjusted accordingly.

Fig. 5.

Very Heavy Patients.—If the patient is very heavy, or the position difficult, the bearers will find it an advantage, while kneeling, to attach their hooks to the links of the short chains attached to each D. These chains have been provided for the special purpose of lengthening the attachment when required, thus making it easier for the bearers to stand up. When the bearers have raised the patient they can re-adjust the attachment to a higher level should they so wish.

Fracture Cases.

Fractured legs may be comfortably supported and carried, with or without splints.

Note.—For the lying cases the rifle butts may be included in the leg straps instead of the special loops. Also the leg straps may be looped into the brace hooks. These modifications allow of wider adaptability.

Advantages.—The greatest carrying power is secured to the bearers by the manner in which the braces distribute the patient's weight. Two bearers can load and lift the patient from the ground, and one can also off-load on to an ordinary stretcher without assistance. The construction of the stretcher prevents the patient slipping. *Both* bearers have *both*

Fig. 6.

hands free, either to support the patient, steady themselves when passing through slippery trenches, over rough ground, climbing gangways, or for removing obstacles from their path. This freedom and power reduce the risk of fall to a minimum, and give confidence to both bearers and patient. The stretcher is well adapted to turning sharp corners and passing along narrow trenches, as has been proved in practice.

Weight 3 *lb.* 5 *oz.*—This stretcher is very light, simple and easy to

make, cheap, comfortable, adaptable and efficient. It is very portable, and can be carried in a haversack. The ease with which cases may be lifted and lowered, combined with freedom of movement of the bearers permits of rapid evacuation of the wounded from the trenches or elsewhere. Bearers returning to the trenches could use the stretcher for carrying water or supplies.

Improvement for Ordinary Stretcher.—Braces as used in the Stirling Stretcher would also be of assistance to the bearers of ordinary stretchers.

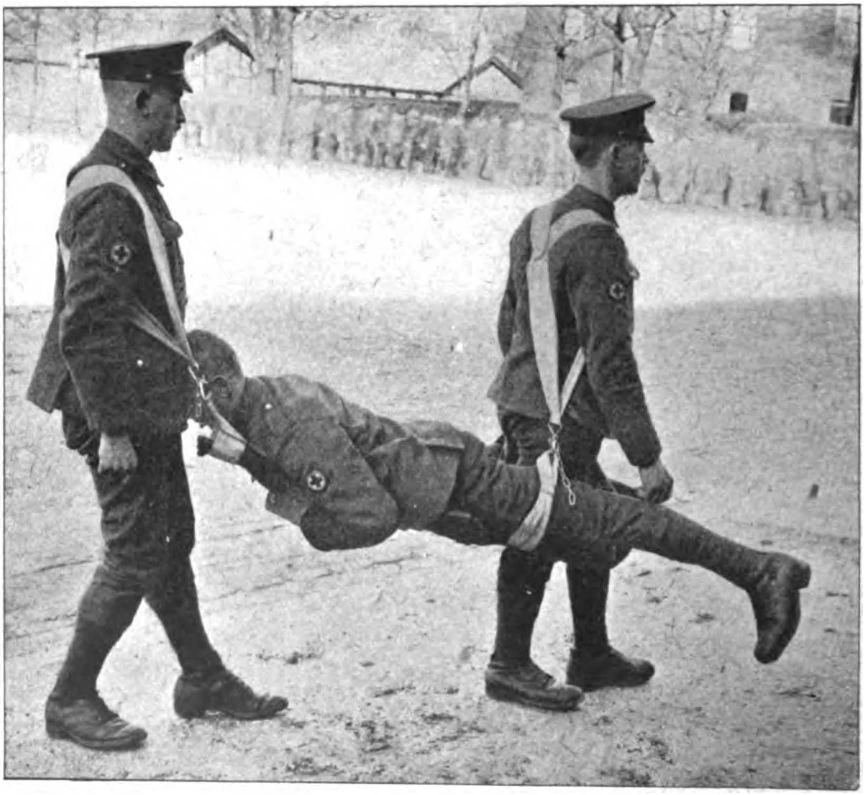


Fig. 7.

They confer greater power for carrying, and allow the bearers to step out freely, thus tending to lessen fatigue, while at the same time the patient is not so shaken as with the single sling method. An excellent substitute for each bearer may be made with two ordinary slings of equal length, crossing on the back, their two ends slipped on to the respective handles of the stretchers.

Carriage of Munitions, Supplies, etc.—The principle of this stretcher is well adapted for the easy and quick carriage of munitions to and from the firing line.

Current Literature.

German Medical Congress at Warsaw. (Verhandlungen der ausserordentlichen Tagung des Deutschen Kongresses für innere Medizin in Warschau am 1 und 2 Mai, 1916.)

(*Continued from page* 402.)

(2) *Typhus Fever.*—The discussion on typhus fever was opened by Generaloberarzt Brauer (Eppendorf), who dealt mainly with the clinical aspect of the disease. It appears that infection was introduced first by refugees from the Balkan war area. Then there were sporadic cases and small epidemic outbreaks in Poland, and afterwards in Moldavia. The severity of prevalence increased until the summer of 1915, by which time the disease was firmly established in various prisoners' camps and elsewhere. No details as to the prevalence of the disease or the case-mortality amongst the German troops are given, but Dr. Brauer's account is founded obviously on a somewhat extensive clinical experience of the disease as it had occurred in Germany during the preceding two years. The cases were generally of a sharply characterized type, but the infection appears to have been complicated quite frequently by other disease. In Macedonia typhus and relapsing fevers were often concurrent; in Moldavia an association of typhus fever with influenza was noticeable. Dr. Jürgens, later in the discussion, also commented on the association of typhus fever with typhoid fever, relapsing fever, malaria, dysentery, diphtheria and influenza. In uncomplicated cases of typhus fever, the acute stage of the illness did not extend over more than a fortnight; and the prognosis in individual cases was determined between the tenth and fourteenth days. The lesions of the capillary vessels of the skin present a distinctive feature of the disease; and the microscopic appearance of the skin lesions, as described by E. Fränkel, are of value in the diagnosis of doubtful cases.

Professor Jürgens (Berlin) discussed the transmissibility of infection by the louse, accepting fully the conclusions arrived at by French pathologists. Typhus fever should not be described as an infectious disease, inasmuch as the transmission of infection was not directly from case to case, but only indirectly by the agency of the louse. The louse itself could become infected only by feeding on a patient who was in the pyrexial or acute stage of the disease. A louse feeding on a patient who was passing through the incubation stage, or who was convalescent, did not become a carrier. The main facts, already proved by French pathologists, as to the almost exclusive importance of the louse as a transmitter of infection were verified by an experiment with prisoners. Twenty healthy persons were confined with twenty typhus fever patients who had been freed from lice, and none of the experimental healthy men contracted the disease. However, under exceptional circumstances infection is possible in some other way, as is suggested by the case of Prowazek who died with typhus fever contracted whilst engaged in a laboratory investigation of the disease. Dr. Jürgens discussed the

possibility that the infected louse may transmit infection to its nits. This appeared to be probable, but the probability of the virus being transmitted to man by the lice hatched out from possibly infected nits was held to be very remote. In all outbreaks of typhus fever the origin had been traceable always to an imported human case. Dr. Jürgens insisted upon the uniformity in clinical type of the cases occurring during an epidemic. Individual cases rarely deviated from the standard type in symptoms. Few unrecognizable, "missed," cases occurred. It did not appear that there was any natural immunity of individuals against infection, but recovery from the disease is followed by a high degree of acquired immunity. The course of outbreaks in camps and other centres of infection was correlated with care given to the destruction of lice on those exposed to infection. As to case-mortality amongst prisoners, the "depressing" effects of warfare with privation appeared to predominate. Amongst the Serbian troops in the field the case-mortality was about the same as that recorded amongst the French troops in the Crimean War—fifty per cent. Amongst Serbian prisoners, in German and Austrian care, "under good conditions," the case-mortality was as low as twenty-five per cent. But amongst prisoners when typhus fever was associated with diphtheria the case-mortality was as high as forty per cent.

Dr. Toepfer had examined material from 400 cases of typhus fever, but had not been able to identify any causative parasite in human cases. Dr. Rocha-Lima (Hamburg) also had not been able to find the parasite in numerous cases of typhus fever which he had investigated. But the virus was, probably, not ultramicroscopic, since experiments had shown that it was not a filter-passer. Toepfer and Rocha-Lima agreed, queit closely, in their respective descriptions of a parasite which they had identified in lice which had fed on cases of typhus fever, but which was not to be found in lice taken from healthy men. The louse parasite is of oval shape; and occurs in pairs, which apparently are held together by an envelope of capsular material. With Giemsa's solution the organism stains of a reddish colour. It is found in the intestinal canal of the louse; and also infecting the intestinal epithelium, in the cells of which it produces definite changes. Lice, hatched under artificial conditions, were fed on typhus patients, and after from four to five days the alleged parasite was found in a few of them. After six or seven days, the organism was identified in about 50 per cent. of the typhus-fed lice. Lice which, for control purposes, had been fed on healthy persons did not show the parasite. The organism in question, which has been named, provisionally, *Rickettsia prowazeki*, has never been identified in human cases of typhus fever, only in lice from human cases.

Dr. Stempell (Munster i.W.), had found in the intestinal canal of lice taken from cases of typhus fever, and in such only, a protozoon-like parasite in the form of spindle-shaped brownish, organisms, with a nucleus-like inclusion, which he believed to be a protozoon, but not identical with *Rickettsia*.

(3) *Trench Nephritis.*—Oberstabsarzt Dr. Hirsch opened a discussion on "Nierenentzundungen im Felde." The incidence of nephritis amongst the troops had been much heavier on the eastern front, where also cases had occurred earlier, than on the western front. Cases tended to occur in groups, and the incidence between the ages of 30 and 40 appeared to be much higher than that between 25 and 30. The urine during an attack

was diminished in quantity, and contained from six to thirty parts of albumin per 1,000, together with some blood. The prognosis was good usually, but there was a marked tendency to recurrence of the trouble. Uræmic symptoms occurred in about ten per cent of the cases, but death from uræmia did not occur with more than one per cent. Neither albuminuric retinitis nor night blindness were observed in any cases. The bacteria found in the urine most frequently were streptococci and *Bacillus coli*, the former of which were found in a considerable proportion of cases. Dr. Bruns (Göttingen), who had investigated thoroughly the excretion of sodium chloride and the conditions of nitrogenous metabolism in these cases, found that in these respects there was not any difference between trench nephritis and the typical *Glomerulonephritis diffusa* of Volhard. With regard to causation, Hirsch regarded cold, damp and the general hardships of war as the principal determining factors. Men suffered more frequently than officers, infantry more frequently than gunners or sappers, and troops in the front lines much more heavily than those in reserve. With regard to seasonal prevalence, the periods of most marked prevalence were March and April, and October and November. Cases did not occur with general epidemic prevalence, but there appeared to be some endemic distribution of cases in foci. Dr. Rumpel (Hamburg) had investigated the influence of physical exertion on the excretion of urine. He examined the urine of troops after a forced march, each man carrying a forty-kilogramme load. At the end of the march, amongst 52 men whose urine examined before the march had been normal, there were 41 who were passing hyalin casts. The urine of 11 out of the 41 showed the presence of albumin, with evidence of the presence of blood in 10 cases.

Reviews.

"GLAUCOMA." A Handbook for the General Practitioner. By Lieutenant-Colonel R. H. Elliot, M.D., F.R.C.S., &c. London: H. K. Lewis and Co. 1917. Pp. xi and 60. Price 3s. 6d. net.

Perhaps the two most important diseases of the eye which occur in general practice are acute glaucoma and iritis. They owe their importance to the fact that each of them call for, and require, *immediate* correct diagnosis and *immediate* and correct treatment. They do not, nor can they wait until they are seen by an ophthalmic specialist. It is, therefore, most desirable for the general practitioner to recognize them at once. It is sad, but true, that many patients have suffered partial or complete blindness because of the lack of general knowledge of these two diseases. We, therefore, welcome a short special treatise on one of them by Lieutenant-Colonel R. H. Elliot, which is intended primarily for general practitioners. Any one of them who reads this little book and learns its lessons ought certainly never to mistake glaucoma for conjunctivitis, iritis, keratitis, &c., which we all know has occurred. Much precious time, and still more precious sight, have thus been too frequently lost.

His explanation of the phases of glaucoma, and the division of all cases into "simple" and "congestive," as opposed to the old idea of "acute,

subacute, and chronic," is very instructive, and makes the subject much more intelligible, and will appeal to all.

Another noteworthy paragraph is that stating the relative importance of symptoms in a progressing case, viz., "field of vision, tension, state of disc, visual acuity."

The treatment of glaucoma by means of regimen, meiotics, and operations, is fully and lucidly dealt with. Although opinion is somewhat divided as to the best form of operation, this book certainly shows clearly what are the prevailing and latest views on the subject.

The only criticism one can offer is that for a general practitioner it may be a little too exhaustive, e.g., the minute differences which occur in the disc and vessels. As a rule, all that a general practitioner can hope to accomplish is to "find" the disc. However, for a really inquiring mind, it is all that can be desired.

"THE TREATMENT OF TABETIC ATAXIA." By Dr. H. S. Frenkel, Heiden, Switzerland. Second revised and enlarged English edition. By L. Freyberger, J.P., M.D., M.R.C.P.Lond., etc. London: William Heinemann. Pp. xv and 209. 129 illustrations. Price 12s. 6d.

Perhaps the greatest single contribution to the therapy of tabes dorsalis during the last century was the work of Dr. Frenkel, first outlined in 1889, and published in English in 1902. In the present edition, Dr. Frenkel's work has been revised and much new matter added, embodying such measures as have been found useful in clinical experience. The physiology of co-ordination is clearly described and an analysis of the various types of ataxia follows. The technique of examination of the tabetic is presented in detail. The greater part of the work is devoted to a description of the exercises necessary to train co-ordination. It is not to be supposed that these are in any way curative of the lesions in the cord. They have for their object the training of nerve fibres other than those formerly used. The conditions influencing treatment, the general supervision of the tabetic, and rules governing the duration of the exercises are discussed clearly and fully. No doubt, the success of the method depends upon the physician's attention to detail and the author has succeeded in explaining each exercise with the most minute detail. The necessary apparatus is described as well as the various orthopædic appliances necessary for the treatment of hypotonia. Dr. Freyberger has added a short chapter of twelve pages on the medical treatment of tabes dorsalis. He first discusses specific treatment aimed at the removal of the cause of the sclerosing process. This should be carried out preliminary to the Frenkel treatment. Then follows a full discussion of the treatment of various symptoms that make the tabetic's life such a miserable one. While much good advice is given in these pages, proprietary drugs receive more attention than they deserve, as they probably accomplish their purpose no better than ordinary British Pharmacopœia preparations. Mention is also made of drugs, at one time thought to be useful, but now considered quite irrational. No mention is made of the newer methods of intrathecal treatment.

The book is well printed and splendidly illustrated. Altogether, it is a work that is absolutely indispensable to the physician who would give his tabetic patients advantage of the best treatment which the medical profession can offer.
W. H. M.

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Original Communications.

INJURIES OF THE BLADDER AND URETHRA IN WAR.

By COLONEL ANDREW FULLERTON, C.M.G., M.D., M.Ch., F.R.C.S.Irel.
Consulting Surgeon, British Expeditionary Force.

WOUNDS of the bladder and urethra have received very little attention on the part of writers on military surgery during the present War. It has been assumed, perhaps too hastily, that there is nothing special to be said about the management of these injuries. During the last year, I have seen most of those that have passed through my area and, though the number has not been large compared with wounds in other regions of the body, some of the cases have been of great interest and importance, especially from the point of view of treatment. I gather from what I have seen that there are practically only two lines of treatment adopted for these injuries at the casualty clearing stations, viz; (*a*) the tying in of a catheter, or (*b*) suprapubic cystostomy. Now, though each of these methods has a definite place as a surgical procedure under suitable conditions, there seems to be a want of appreciation in the minds of operators as to the objects to be attained by these methods and the dangers attending their indiscriminate use. A few remarks on the types of injury usually met with, and the lines of treatment I have found most beneficial, may not, therefore, be out of place.

WOUNDS OF THE BLADDER.

Wounds of the bladder may be produced by bullets, shrapnel, shell, bombs, etc., and have certain dangers distinct from those

produced by these missiles in other parts of the body. The more ragged the edges and surfaces of the missile, the more likely is clothing and dirt to be carried in and produce the usual sepsis. The missile may reach the bladder laterally, antero-posteriorly or from above or below, and the track is often long and tortuous. Complications may occur in the form of fractures of the femur, pelvic bones, or spinal column; injuries to large vessels or nerves; injuries to the intestine; or extravasation of urine. A troublesome complication is involvement of the rectum, with the discharge of fæces into the bladder, of urine into the rectum, or of both through the wound in the soft parts. Wounds of the bladder may be intra- or extraperitoneal or both, and each variety has special dangers and requires special treatment. The intraperitoneal wounds are, as a rule, reached with comparative ease, whereas those outside the limits of the peritoneum may be quite inaccessible, especially those at the base and sides. The missile may stop short after wounding the bladder; it may enter and remain in the viscus; or it may pass through, leaving wound of entry and exit. The wounds seen have been of all sizes and shapes, from small punctures to the most extensive laceration.

The signs and symptoms of injury to the bladder will, of course, vary with the position and extent of the wound and the concomitant injuries to other organs and structures. Intraperitoneal injury will probably be associated in many cases with injury to the intestine, and the usual signs of a ruptured viscus will be present. Urine may be discharged in such quantities into the peritoneal cavity that none passes by the urethra. A perforating wound of the abdomen in the bladder region will generally be explored, and it will not be necessary to adopt the ancient and clumsy method of pumping into the bladder a known quantity of fluid and measuring the amount returned. If the wound is small and a cystoscope is at hand, valuable information may be obtained as to the size and position of the opening or openings and the presence or absence of a foreign body. If the patient can void urine at all, hæmaturia will probably be present. Hæmaturia itself is not, however, evidence of a direct wound of the bladder. I have seen two cases in which the latter showed splashes of hæmorrhage into the mucous membrane, though the missile had not directly involved the viscus. The first occurred in a case of injury to the spine in the lumbar region, and the second in a case in which the missile had traversed the posterior wall of the rectum without touching the bladder. As previously stated, in most cases of intraperitoneal

injury the abdomen will be explored before the patient reaches a base hospital, and, under present conditions, the same procedure should be carried out even in cases of doubtful injury. In extraperitoneal wounds the chief signs and symptoms are escape of urine from the wound, hæmaturia, and later, in many cases, the signs and symptoms of cystitis. The urine may not escape from the wound for several days after injury, or, in other words, until the sloughs have begun to disintegrate and separate. The patient may pass some urine by the urethra, but the fistula will leak more or less continuously in addition. If the fistula is narrow the urine will be discharged more freely when the bladder has become to some extent distended and the patient makes efforts to micturate. In other cases the leak will be more uniform and continuous. Hæmaturia may be severe, and, in some cases, huge clots may form in the bladder. These complicate treatment and are a serious source of trouble and danger, both from the mechanical difficulty they offer to normal micturition and to catheterization, and from the ease with which they become infected. When cystitis occurs, frequent attempts to micturate, scalding, straining and penile pain add to the patient's discomfort.

Wounds of the Urethra.

For our present purpose it will be convenient to divide these injuries into two classes; those of the pendulous urethra and those of the fixed portion. The latter includes the bulbous urethra, the membranous urethra and the prostatic urethra. Wounds of the pendulous urethra have not been frequent in my experience, and they need not detain us here. Wounds of the fixed urethra are comparatively frequent and are produced by missiles which penetrate through the buttocks, the upper part of the thighs, or, more rarely, the front or back of the pelvis. Missiles passing transversely at the level of the lower part of the great trochanter may involve the prostatic portion. Those passing transversely at the level of the middle of the small trochanter may involve the bulbous portion. Between these levels the membranous urethra is liable to be injured. Concurrent injury of the rectum may occur in antero-posterior wounds. Any degree of injury to the urethra may be met with, varying from slight contusion to complete destruction of a segment. The signs and symptoms include possibly a wound in the perineum, ecchymosis of the perineum or scrotum or both, hæmorrhage from the urethra independent of micturition, difficult micturition, or complete retention, and, in some cases, extravasation of urine. If an

open wound exists which communicates with the urethra, a urinary fistula is established which leaks only when the patient passes water, provided the sphincteric apparatus of the bladder is intact.

Treatment of Wounds of the Bladder.

Intraperitoneal wounds will usually be treated at the casualty clearing stations. These injuries may be complicated by wounds of the intestine, which will be dealt with in the usual way by infolding or excision. The wound in the bladder wall, if easily accessible and of moderate dimensions, may be excised, so as to bring fresh healthy surfaces together with a good prospect of prompt and sound healing. I have recently been advocating the use of the thermo-cautery to sterilize the edges of wounds which are to be excised in other parts of the body. The charred edges are removed and the fresh surfaces are brought together. Foreign bodies will, of course, be removed from the cavity of the bladder, if present, and from other situations in the pelvis, if accessible. Catgut of good quality ought to be used to bring together the muscular walls rather than non-absorbable material, in order to avoid subsequent calculus formation. Fine silk or linen thread may be used for the peritoneal suture, though good catgut will answer the purpose. The sutures should be continuous in order to render the bladder water-tight. If the wound is very extensive and much laceration is present, it may be impossible to close the bladder, in which case an attempt must be made to render the wound in the latter extraperitoneal. In most cases of intraperitoneal bladder wounds operated on at the front the viscus has been completely closed. The peritoneal cavity is now cleansed, and, if much soiling is present, it is wise to insert a drain into the recto-vesical pouch. The question now arises as to whether a catheter ought to be tied in. In transperitoneal operations in civil practice, I have found it unnecessary; at the same time, it is well to encourage the patient to avoid distension, and, if necessary, to pass a catheter every four hours until it is judged that union is firm. If the peritoneal surfaces have been well turned in and a continuous suture employed, leakage into the peritoneal cavity is very unlikely to occur. The objections to the practice of tying in a catheter will be dealt with later. A case recently operated on by Captain D. C. Taylor at a casualty clearing station, which subsequently came under the care of Major West at a base hospital, will illustrate the correct method of dealing with cases of this sort. I am indebted to Captain Taylor for notes of this case, sent down with the patient, but I shall use only those that bear on the ques-

tion under consideration, leaving Captain Taylor to publish later the full account with that of other abdominal cases operated on by him at his clearing station. Pte. McK. was wounded with high explosive shell on June 5, 1916, three hours before admission. The fragment entered on the left side in the mid-axillary line, 1½ inches above the iliac crest, and was retained. The patient had a pulse of 140 on admission, vomited, and had blood in the urine withdrawn by catheter. Laparotomy was performed, the pelvis was found full of blood and the ileum perforated in many places. Four feet of intestine were removed. There was a small hole in the posterior wall of the bladder, and a piece of shell was removed from the latter. The bladder wall was sutured, a drain was placed in the recto-vesical pouch, and the abdomen was closed. A catheter was passed every four hours for three days. I saw the patient with Major West on June 14, 1916, i.e., nine days after injury. The wound in the abdominal wall had healed by first intention, except for the track of the drainage tube, and the patient was passing normal urine and was in a highly satisfactory condition. It will be observed that no catheter was tied in, and although a piece of shell was removed from the bladder, it was not considered necessary to drain the latter. Captain Taylor is to be congratulated on the successful issue of this case.

Extraperitoneal wounds are treated for the most part at the base, and offer problems for successful management not quite so simple as might at first sight appear. In those cases in which the rectum is also wounded, and fæces are discharged into the bladder, a colostomy must be done to divert the flow. A transverse colostomy above the umbilicus is much better than an inguinal colostomy in these cases on account of the proximity of the latter to the suprapubic area should it be considered necessary to undertake any operation on the bladder in that region. Further advantages of transverse colostomy are as follows:—

(1) The stoma is far removed from the wounded area.

(2) The opening is easily controlled.

(3) Restoration of the continuity of the bowel is easily accomplished when the need for an artificial opening is past.

(4) Should it become necessary later to remove any part of a damaged rectum, the pelvic colon can be mobilized and brought down to supply the deficiency, if it has not previously been interfered with by an inguinal colostomy.

A case which I saw in consultation with Captain Fitzmaurice Kelly at a base hospital will illustrate some points in the management of cases of this kind.

Pte. S. was wounded on August 2, 1915, by a bullet which entered one inch above the pubis and one inch to the right of the middle line in front. Passing from before back, it emerged through the third piece of the sacrum, also to the right of the middle line. The bladder is stated to have been full at the time of injury. The patient was admitted to a base hospital on August 8. On admission, there was found to be slight leakage of urine from the anterior wound; the bulk of the urine, however, and all the fæces, being discharged from the large exit wound. On August 9, Captain Kelly brought out the transverse colon, which he opened on the 10th. Irrigation of the bladder was carried out through the wound in the sacral region by means of a Carrel-Dakin tube and eusol. The wounds rapidly cleaned up, and normal micturition was restored early in September, when the cystoscope showed both bladder wounds healed, and a disappearing cystitis. The patient was discharged to England on September 21, 1915. Captain Kelly recently received a letter from the medical officer in charge of the case in England, dated March 2, 1916, which stated that the patient was practically cured and that the colostomy wound had been closed. There was now no discharge from the remains of the sinuses. It will be observed that in this case suprapubic cystostomy was not performed. The opening at the base of the bladder was sufficiently large to allow of proper cleansing and drainage, and there was no point in making another, or rather enlarging the existing one, in the suprapubic region. I am indebted to Captain Kelly for notes of this case. Extraperitoneal injuries to the bladder are frequently produced by missiles which enter through the buttocks and upper parts of the thighs. The track of the missile is frequently long and tortuous, being rarely less than two inches, and frequently as much as six inches or more in length. Notwithstanding their tortuous character, many of these wounds, with urine pouring from them, come down from the Front in a surprisingly healthy condition, and I have in these cases decided against any further operation on the bladder itself. This treatment is not in accord with the usually accepted practice, which is to perform a suprapubic cystostomy. The object of this appears to be to prevent urine from passing over the wounded surfaces and to drain the bladder. Now, most of the men in the fighting line have a most efficient saline antibacterial fluid in the sterile secretion which passes into their urinary bladder from their kidneys. If proper drainage be established in the wound leading down to the bladder, urine flows through the fistula, and the wound is kept

continually irrigated. If the urine remains undecomposed, there is no necessity to interfere with such an admirable arrangement. It is true that the bladder may become infected from the wound, and that instead of aseptic urine a highly irritating fluid may be forced through the fistula. It will be seen from what follows that this can be prevented to a large extent, and that, even if the urine has been allowed to become foul, properly conducted irrigation of the bladder will, in some cases at least, restore the urine to its normal sweetness. In addition to the surgical treatment, urinary antiseptics may be given internally, in the hope that they may have a beneficial effect on the urine and on the wound. If the bladder is severely lacerated and large sloughs are likely to separate into and foul its interior, there can be no question that the bladder must be drained. I shall be reminded, no doubt, of the disastrous results of urinary extravasation in cases of ruptured urethra in civil practice. In those cases in which the urethra gives way behind a stricture the urine is likely to be septic, and, in both these and traumatic cases, the urine is forced under considerable pressure beneath resistant fasciæ. Sloughing of skin and subcutaneous tissue is, however, not unknown when other fluids are introduced under the skin. I have in my mind at the moment a case of this type in which a huge slough occurred in the upper part of the thigh after a subcutaneous injection of saline. Further, the surprisingly rapid recovery of cases of perineal section demonstrate the innocuous effect of the urine which necessarily flows over such a wound. Let us suppose that we have a case of a bullet wound in the buttock involving the bladder. Urine is continuously forced out through the fistula. The usual suprapubic cystostomy is performed. Let the urine which lies at the bottom of the bladder, no matter what method of drainage be employed, be taken and examined. Instead of clear urine a turbid fluid containing pus and many varieties of micro-organisms will be found, in other words a mixed infection has occurred. Suprapubic cystostomy does not necessarily prevent leakage from the fistula, and I have under observation at the present moment two cases in which, notwithstanding suprapubic cystostomy, urine still finds its way through wounds in the buttocks. If the urine in the bladder can be kept clean, and the fistula well drained, I believe it will be well to allow the patient to continue to flush his own wound from within outwards with a highly cleansing fluid like fresh urine. If the bladder becomes foul, and irrigation fails to control the sepsis, and especially if the patient begins to lose ground, cystostomy must be performed at once.

With regard to the presence of foreign bodies in the bladder, Captain Taylor's case previously mentioned and other cases we have seen show that the bladder can be completely closed after removal of the missile, if the wound has been intraperitoneal. With an extraperitoneal wound, say near the base of the bladder, and a foreign body removed by suprapubic cystostomy, the indications are not so clear. Extraperitoneal suture is not so likely to be satisfactory as intraperitoneal. The treatment to be adopted will depend on the condition of the bladder; I should like to try closure of the suprapubic wound in the bladder, the insertion of a drain into the space of Retzius, and assiduous attention to the bladder. If the latter becomes septic and the sepsis cannot be controlled by irrigation it is easy to open up the cystostomy wound. I may mention here that in wounds of the loin involving the kidney or ureter the resulting urinary fistulæ seldom give rise to serious trouble. Most of the cases I have seen have done well, though the wounds have been continually soaked with urine.

The following two cases will illustrate the type of wound involving the bladder, in which I think less severe measures than suprapubic cystostomy will be sufficient. Sapper F. was wounded on February 2, 1916, by a bullet which entered over the great trochanter on the right side and lodged, as was afterwards ascertained, in the left thigh, passing across the pelvis and causing much comminution of the right great trochanter. X-ray examination showed, in addition, fracture of the ilium and ischium on the same side. There was severe sepsis with an area of cellulitis and dusky red discoloration of the skin nine inches in diameter round the wound. Captain Simpson, who was doing temporary duty at a base hospital, enlarged the wound and counter-drained in the region of the tuber ischii. In addition to the wound, there was ecchymosis of the scrotum, but there were no urinary symptoms. Eleven days after injury, urine began to flow from the thigh wounds, at first independent of micturition, but later only on efforts being made to pass water. I was asked by Captain Bryan, who was now in charge of the case, to see the patient with a view to deciding as to the advisability of cystostomy. The cystoscope showed a healthy bladder. From the direction of the wound we came to the conclusion that the viscus was damaged near the neck and out of sight, about six inches deep from the entry wound in the thigh. As the patient's condition was good and the wounds were cleaning up and granulating well we decided against suprapubic cystostomy. On March 19 (about seven weeks after injury) a note was made to the

effect that normal micturition was becoming established and that the leak of urine from the wound was very slight. A fortnight later the leak had ceased altogether and the case became one of fracture of the upper third of the femur. The patient was evacuated to England on June 14, 1916, with exact alignment of his femur with $\frac{1}{8}$ inch of shortening. A small sinus led down to a piece of necrosed bone which will probably need removal. It is quite possible that this was really a case of wound of the urethra near the neck of the bladder and not of that organ itself, but it is suitably introduced at this stage as an illustration of the policy of non-interference. The nursing of a case of compound fracture of the thigh in the upper third is difficult enough of itself, but if, in addition, the patient has a suprapubic wound leaking urine the difficulties are much increased. Captain Bryan's hammock bed proved invaluable in the management of the case. The second case, which I saw in consultation with Major West at a base hospital, may be described as a test case. Pte. H. was wounded on May 26, 1916, by two fragments of shell which entered the pelvis through the right buttock. X-ray examination showed two fragments of shell in the pelvic cavity. The one which was judged to have wounded the bladder was situated on the left side seven inches from the plate which was placed on the patient's back. To reach its final destination the missile probably passed through the following structures: skin, gluteus maximus, great sacro-sciatic foramen close to the gluteal vessels, obturator internus, levator ani, vesiculæ seminales, and bladder wall (twice). The missile probably passed just inside the great sciatic nerve. There was no sign of fracture of the bony pelvis in the X-ray photograph. There was no leakage of urine until four days after injury, when a little began to trickle through the wound, independent of micturition. On June 1, patient was unable to pass water himself and complained of urgency. Up to this he had been able to pass some by the natural passage. A catheter withdrew six ounces of turbid urine. The patient was examined with the cystoscope on June 1. While on the operating table, he passed some foul-smelling urine loaded with pus. The cystoscope showed general cystitis. On the left wall of the bladder was an area covered with dead white membrane, in the vicinity of which were some ecchymosed spots (point of exit of missile from bladder?). On the posterior wall was a punched-out circular aperture rather less than the size of a threepenny-piece. Inside this circular area, which looked dark in colour, were some flecks of

mucopus and some small sloughs. Per rectum, no foreign body and no thickening could be felt. The patient had a slight evening rise of temperature, but was otherwise in good condition. Major West was at first strongly in favour of suprapubic cystostomy. After consultation, however, we decided to begin with the less severe measure of washing out the bladder frequently and thoroughly, first with boiled water to get rid of the mucus and pus, and then with a weak solution of nitrate of silver (two to ten grains to the pint). This alternate washing with water and nitrate solution was carried out at first twice, and then once a day. Three days' treatment produced a great improvement, so that even at this early period the urine was almost clear. The patient continued to improve and was discharged to England on June 13, less than a fortnight after the commencement of this treatment, with his wound dry and his urine normal. His temperature had been normal for a week. In this case foul-smelling urine was rendered sweet after a few days' irrigation. The patient will probably be fit to rejoin his regiment in a few weeks, whereas if suprapubic cystostomy had been performed his convalescence would have been much more prolonged. The foreign bodies were left, as it was thought that more damage might be done by delving in the pelvis than by leaving them alone, especially as the patient apparently suffered no inconvenience from their presence. To sum up, I am of opinion that suprapubic cystostomy is not necessary in many cases of wounds of the bladder provided that the latter can be kept clean and the external wound adequately drained. If there is likely to be much sloughing of the bladder walls, if there be severe and continuous primary or secondary hæmorrhage, or if there be uncontrollable sepsis of the bladder, cystostomy will be the correct treatment. Cystostomy is performed not so much for any beneficial effect it may have upon the original wound, which must be dealt with on ordinary surgical principles, but in order to drain a badly infected bladder, and to prevent the spread of infection to the kidneys. Extravasation of urine in concealed situations must be prevented by suitable incisions.

Treatment of Wounds of the Urethra.

The usual method of treatment in cases of wounds of the urethra seems to be as follows:—

An attempt is first made to pass a catheter. If this succeeds it is tied in and the patient sent to the base. Should catheterization fail, suprapubic cystostomy is performed. Neither of these

methods is, in my opinion, the best that can be done for the patient. Take the case with a catheter tied in first. An instrument cannot for long be retained in the urethra without causing urethritis. In a short time pus is seen oozing by the side of the catheter and a dirty caked mass is found surrounding it, at the meatus. The wound in the urethra, which may have been caused by a clean bullet, is now infected and a slight injury, perhaps, is turned into a suppurating wound. But this is not the worst that may happen. The infection may extend back to the bladder, and cystitis occur, or it may extend farther still so as to involve the ureters and kidneys. I have seen all these things happen. The infection or additional infection of the wound of the urethra produces much greater infiltration than would have occurred otherwise, and the foundation of a severe stricture is thus laid. In addition to this, the catheter frequently becomes blocked, and it is not uncommon to find a full bladder with a blocked catheter effectually preventing micturition. Again, even in a few days, if the catheter is not removed, phosphatic deposit forms on the intravesical portion, the withdrawal of which excoriates an already inflamed urethra. The performance of suprapubic cystostomy is quite unnecessary, except perhaps in those rare cases in which blood, finding its way back into the bladder, forms large clots incapable of being evacuated. The treatment I suggest and which is carried out in all cases referred to me is as follows:—

If the urethra is so damaged that either the patient is unable to void urine or is likely to have extravasation in attempting to do so, perineal section is performed. In all cases of doubt the same procedure is adopted. A dilator, a catheter, or any suitable instrument is passed down to the seat of injury, and, keeping strictly to the middle line, the point of the instrument is cut down upon in the perineum. Blood-clot, irreparably damaged tissue, and foreign matter are removed, hæmorrhage is arrested, and free drainage is established after thorough cleansing of the wound. The patient is now encouraged to pass his urine through the wound, hot compresses being used to relax his sphincter, if necessary. If at first failure to pass urine should occur it is better in my opinion to aspirate the bladder through healthy tissues above the pubes, than to poke about in the perineal wound in the hope of finding the proximal end of the urethra or infect the healthy bladder by an instrument passed through a septic wound. When the sepsis has been controlled, dilatation, if necessary, can be carried out, and later plastic operations can be successfully attempted.

Here, again, the normal urine of the patient acts as an efficient cleansing lotion and he flushes his wound from the depths outwards every time he micturates. Treated on these lines cases of this sort heal with the greatest rapidity. The following two cases will illustrate some of the points I have tried to make. Pte. J. W. H. was wounded on September 28, 1915. A bullet entered the right groin in the region of the external abdominal ring and, passing obliquely across the pelvis, lodged in the left ischio-rectal fossa. A catheter was tied in at the C.C.H. and the patient was passed on. He was admitted to a base hospital on September 30, under the care of Captain Wolfenden. He was then in a toxic condition, though the temperature was only 99° F. and the pulse 100. He complained of pain and tenderness in the suprapubic region. *No urine was passing through the catheter, though the bladder was full.* There was ecchymosis of the perineum, but no extravasation of urine. On October 1 the patient had a rigor, and Captain Wolfenden asked me to see him. We decided on perineal section. Captain Wolfenden accordingly explored the perineum and found the bulbous urethra lacerated, and a portion of the corpus spongiosum torn away. Unable to find the proximal end of the urethra, he opened the bladder above the pubis and drained it. The bullet, which had not injured the bony pelvis, was removed at the same sitting. The patient died from shock and toxæmia the same evening. For a similar case in future I should suggest the following treatment. After injury, a perineal section should be done so as to inspect the injured parts, remove clots and tags, arrest hæmorrhage, provide free vent for the urine so as to avoid extravasation, and thoroughly cleanse the wound, which should be left widely open. The patient should be encouraged to pass urine, and if unable to do so aseptic puncture of the bladder in the suprapubic region should be resorted to till micturition has been established through the perineum. The second case, Rifleman R., was wounded by a machine-gun bullet on February 17, 1916. Blood flowed from the urethra after injury. There was a small clear circular entrance wound, 1½ inches below and to the outer side of the left ischial tuberosity. The exit wound was on Nelaton's line, half-way between the great trochanter and the ischial tuberosity. The bullet had in its passage also made a figure-of-8-shaped wound in the perineum, close to the bulb. There was a considerable ecchymosis of the perineum. The bullet had been extracted at the field ambulance. A No. 10 rubber catheter had been passed and tied in at the casualty clearing

station. On arrival at the base on February 18, 1916, *the catheter was found to be blocked and no urine was passing through it. There was pus at the urethral orifice.* The catheter was removed and I was asked to see the case with Captain Simpson. Perineal section, with treatment on the lines already indicated, was advised. Captain Simpson operated on February 19 and found the urethra divided as to three-fourths of its circumference about one inch from the commencement of the bulb. He thought the case favourable for an attempt at suture of the divided urethra. The attempt failed, however, urine leaking freely on the third day. On the 26th, nine days after receipt of the injury, leakage from the perineum had ceased; on the 29th, the perineal wound was almost healed; and on March 1 the patient was evacuated to England with his wound quite healed. In this case an attempt was made by Captain Simpson to reform the urethra round a catheter. This will rarely be desirable or feasible with gunshot wounds under war conditions. In case such an attempt was made I should suggest suture of the roof, leaving the floor of the urethra quite free for drainage; and the avoidance of a catheter. An operation on these lines was suggested for stricture by a writer in the *British Journal of Surgery* more than a year ago.

I do not know if the views expressed in this paper will meet with general acceptance. They are only put forward to stimulate those who are dealing with cases such as I have described, to consider each on its merits, rather than adopt any hard-and-fast rule for all.

THE CARRIAGE OF CYSTS OF ENTAMŒBA HISTOLYTICA AND OTHER INTESTINAL PROTOZOA AND EGGS OF PARASITIC WORMS BY HOUSE-FLIES WITH SOME NOTES ON THE RESISTANCE OF CYSTS TO DISINFECTANTS AND OTHER AGENTS.[1]

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The importance of house-flies in the spread of various bacillary infections of the intestine has been well established and though a similar distribution of the infective agent in amœbic dysentery has been suspected no very definite experiments have been made to prove it. For this reason we feel that the observations to be recorded below are of considerable importance, for they establish beyond dispute the great danger of the house-fly as a factor in the spread of the disease.

Amœbic dysentery is caused by an amœba, *Entamœba histolytica*, which lives in the large intestine, where it invades the wall of the bowel and produces the dysenteric ulceration.

In the acute dysenteric process only the free motile amœbæ are to be found in the fæces, but as the acute symptoms abate smaller amœbæ (minuta forms) occur and many of these become encysted in the large intestine in transparent capsules, in which condition they are passed from the intestine in the fæces in very large numbers. The cysts of *E. histolytica* measure from six to eighteen microns in diameter. On account of the capsule, they are relatively hardy structures which, though they cannot withstand drying, will nevertheless survive for considerable periods if they remain moist. The spread of amœbic dysentery is determined by these cysts, for if ingested in water or food each one gives rise to four amœbæ under the influence of the pancreatic fluid. The four small amœbæ grow into adult forms of *E. histolytica*, which invade the tissues of the large intestine and produce amœbic dysentery.

The cysts are often passed in very large numbers by "carriers,"

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[1] Memorandum published in Egypt, April, 1916.

which are cases which have partially or apparently wholly recovered from amœbic dysentery either after inadequate or ineffective treatment or after no treatment at all. If the cysts from such cases find their way into the water supply or into moist food without having been dried they are likely to give rise to outbreaks of amœbic dysentery, so that any agent like a fly which brings about their distribution must be regarded with suspicion.

A.—EXPERIMENTS WITH HOUSE-FLIES (MUSCA AND FANNIA).

(1) *Do the Flies ingest the Cysts?*—Kuenen and Swellengrebel (*Cent. of Bakt.*, Bd. 71), working in Sumatra, showed that flies ingested cysts of *E. histolytica* when they fed on infected fæces. This point we readily confirmed by allowing flies to feed on fæces containing cysts and dissecting the flies shortly after.[1] We found in every case that the gut contained fæces and that in this fæcal material in all parts of the intestine of the fly the cysts occurred just as they had done in the specimen of fæces on which the flies had fed. We were able to demonstrate also that the flies ingested in a similar manner the larger cysts (fifteen to twenty-five microns) of the non-pathogenic human entamœba, *E. coli*, and the cysts of the flagellate *Lamblia intestinalis*.

(2) *Survival of the Cysts in the Intestine of the Fly.*—Kuenen and Swellengrebel stated that the cysts quickly degenerated in the fly's gut and soon became unrecognizable. We dissected flies at various intervals after feeding and noted that so long as fæces were present in the gut cysts could be found, but that they vanished with the disappearance of the fæces from the flies' intestines. Cysts of *E. histolytica*, *E. coli* and *Lamblia intestinalis*. were all found in the intestine twenty-four hours after the last feed on fæces. After this time the flies have generally emptied their gut of fæces and then no cysts could be discovered. In one instance cysts of *E. coli* were found in the gut so long as forty-two hours after the last feed. The question of the vitality of these cysts is discussed below, but it may be remarked here that from their normal and living appearance after their sojourn in the fly there can be no doubt that the majority were still alive and therefore infective. Furthermore we have observed the passage through the intestine of the fly of living and active Trichomonas. The application of the eosin test, to be described below, also lent support to this view.

(3) *How do the Cysts escape from the Fly?*—We may say at once that we have not yet been able to demonstrate that flies regurgitate

[1] Captain J. G. Thompson, R.A.M.C., informed us that he had made a similar observation that flies were able to ingest the cysts.

through the proboscis cysts they have previously ingested. In the fæces passed by the flies soon after feeding the cysts are readily found.[1] Within twenty to thirty minutes of feeding on human fæces, the flies begin to deposit droplets of liquid fæces and in these it is easy to detect the unaltered and living cysts. If the fly has continuous access to fæces it will feed every few minutes and as often evacuate its intestinal contents. The amount of material passed through the gut of a single fly in this way must be considerable and within a few hours many thousands of cysts must have followed this course. The cysts, however, may remain in the gut of the fly for some hours and be deposited later, as the following experiment demonstrates. A batch of flies was fed upon fæces containing cysts of *E. histolytica*. After they had fed, the fæces were removed and the flies left without food for sixteen hours. They were then given sugar and water upon which they fed greedily. Shortly after this, they passed droplets of fæces and in these, typical unaltered cysts were found. It is thus evident that flies which have ingested cysts will retain them for considerable periods only to deposit them later upon anything which appeals to their varied tastes. The experiments described were conducted with small numbers of flies, yet there was no difficulty in recovering the infective amœbic cysts in the numerous droplets of fæces they passed. When one reflects on the myriads of flies which swarm about the latrines or fæces deposited in the open in hot countries, one can only be surprised that amœbic dysentery is not more widespread than is actually the case. In these countries fæces, especially when liquid, are devoured and transported *in toto* by these insects only to be deposited broadcast in millions of cyst-infected fæcal droplets upon all kinds of human food, which appears to occupy as an article of diet only a second place in the estimation of these dipterous pests.

It might be urged that cysts could be transported by the adherence of moist fæces to the legs, proboscis and body of the fly. Observations on this question were made by Kuenen and Swellengrebel, who, like Nicol in his work on the passage of worm ova through flies, came to the conclusion that these insects when fouled by fæces did not move far till they had perfectly cleaned themselves. In so doing the flies removed most of the fæces, the remainder drying so that all the cysts were killed. The above-mentioned observers (Kuenen and Swellengrebel) failed to demonstrate the

[1] We explained our results and methods to Captain J. G. Thompson, R.A.M.C., who subsequently was able to repeat and confirm some of our observations on the escape of cysts from the fly.

passage of cysts through the intestine and so concluded erroneously that flies were of little consequence in the distribution of the cysts of *E. histolytica*. The experiments we have made entirely disprove this assumption, for with the rapid passage of ingested cysts through the intestine the fly becomes a very potent factor in the spread of amœbic dysentery.

These experiments have been conducted with the ordinary house-flies (Musca and Fannia), and with the blue-bottle fly (Calliphora), and the green-bottle fly (Lucilia). We have observed the passage through all of these of the cysts of *E. coli*, *E. histolytica* and *L. intestinalis*. Quite recently we have examined 200 wild house-flies captured at random in different localities in Alexandria. The flies were given no food whatever by us, but were allowed to deposit their fæces in glass tubes. It was evident that many of these had been feeding on human fæces, and in the droppings of fifteen we found not only the cysts of *E. histolytica*, *E. coli* and *L. intestinalis*, but also the oöcyst of a coccidium and the eggs of various parasitic worms (*Tænia saginata*, *Ankylostoma duodenale*, *Trichocephalus trichiurus*, *Heterophyes heterophyes*, and the comparatively enormous lateral-spined egg of Bilharzia). One fly which deposited cysts of *E. histolytica* was actually captured in a cook-house. It is evident therefore that flies under natural conditions are actively concerned in the carriage of the cysts of the dysentery amœbæ and other organisms. Of the 200 flies the droppings of which were examined, fifteen were found to have deposited cysts of protozoa or eggs of parasitic worms. All the infected flies came from near the cook-house of a hospital compound which was separated from a native village by a single wall.

(B) Experiments on the Resistance of Cysts.

The great difficulty in studying the resistance of the cysts is the want of a reliable test as to their viability. Kuenen and Swellengrebel employed the eosin test, which seems to us fairly trustworthy. It is generally agreed that a living cell will not stain with dilute eosin, whereas a dead cell will stain at once. This test can be readily illustrated by the action of heat on the cyst of *E. coli*, *E. histolytica* and *L. intestinalis*. Fæces containing these cysts when mixed with dilute eosin show under the microscope a red background of stained debris while the white unstained cysts stand out clearly. A few of the cysts, however, may stain with eosin and these are probably dead ones. If the fæces mixed with a little water is heated to boiling point for a second it will be found that after this treatment the eosin will stain all the cysts

a deep red instantaneously. In this case there can be little doubt that the cysts have been killed by heat. Drying the cysts has a similar effect so far as making them stain with eosin is concerned. With disinfecting agents, the stronger the solution employed, the more quickly do the cysts acquire the property of taking up the stain. Reagents such as strong sublimate solutions which would be expected to kill the cysts instantaneously similarly cause them to stain with eosin. It seems therefore clear that the eosin-staining cysts are dead though it may be argued that others which do not stain may be dead, also or, at any rate, non-infective. Still, if we accept the eosin test as a criterion and regard all unstained cysts as living, the error in judgment will be on the safe side. The following experiments have been made :—

(1) *Drying.*—The cysts of *E. histolytica* do not appear to withstand drying, for they stain with eosin at once after this. Kuenen and Swellengrebel likewise found that drying killed the cysts. The test can be applied by simply allowing fæces to dry at laboratory temperature. The dried fæces is emulsified with saline solution or water, when it will be found that the cysts will stain at once if eosin is added.

(2) *Moisture.*—The cysts will survive for over thirty days in water, an observation which confirms the results of Kuenen and Swellengrebel. Apparently the cysts survive best if there is considerable dilution of fæces with water, so that intense bacterial or fungoid overgrowth does not take place.

(3) *Chemical Agents.*—The experiments were conducted by mixing solutions of chemicals of certain strength with equal volumes of emulsion of fæces in water. Small quantities of the mixture were taken out from time to time and tested by the addition of a drop of eosin solution. The staining of the cysts by the eosin occurred practically instantaneously when it took place at all. When some time was required to kill all the cysts it was found that during this period the percentage of stainable cysts gradually increased.

(*A*) *Emetine Hydrochloride.*—The cysts of *E. histolytica* are much more resistant to this drug than are the free amœbæ, for in a strength of 1 in 200 (equal parts of 1 in 100 emetine and fæces emulsion) it failed to kill the cysts even after nine hours exposure. It has been claimed that a strength of 1 in 100,000 will quickly kill the free amœbæ.

(*B*) *Cresol.*—This reagent killed all cysts immediately in a strength of 1 in 20 (equal parts of 1 in 10 cresol and fæces emulsion), in one minute in a strength of 1 in 30, in half an hour in a strength

of 1 in 100, in one hour in a strength of 1 in 200, and not at all in a dilution of 1 in 2,000.

(*C*) *Carbolic Acid.*—The cysts were all killed in fifteen minutes by 1 in 40 carbolic acid, and in seven hours by 1 in 100, while a 1 in 200 solution failed to kill all the cysts in eight and a half hours.

(*D*) *Formalin.*—The cysts were exposed to 1 in 100 formalin. Even after four hours, they did not stain with eosin, though they were very much shrunken and distorted and giving every appearance of having been killed.

(*E*) *Acid Sodium Sulphate.*—This drug in tablet form as used for the purification of water had no action on the cysts.

(*F*) *Chlorinated Lime Tabloids* (*B. W. & Co.*).—This reagent as used for water sterilization had no action on the cysts. The tabloid gives an equivalent of one grain (0·065 gramme) of chlorine per ten gallons of water (1 in 700,000).[1]

From the foregoing observations it may be concluded that the cysts of *E. histolytica* are fairly resistant structures, but are quickly killed if deprived of moisture. They certainly will not withstand the desiccation of a tropical sun, so that it seems improbable that wind in blowing about dust can play an important part in their spread. Wind, however, may distribute moist particles of fæces or fragments only externally dry or even portions adhering to pieces of paper or leaves. Of the few reagents we have tried cresol seems the best and would be effective in a strength of 1 in 40 or 50. It is important that the disinfectant should have access to the cysts, and to this end the fæces must be intimately mixed with the fluid added to it. Cresol can, therefore, be employed safely for the disinfection of dysenteric stools, or the hands of those who have to deal with patients. Flies must be of very great importance in the spread of amœbic dysentery, and the results recorded above afford another argument, if, indeed, any further argument is needed, in favour of unceasing warfare against these noxious pests. It may be impossible to isolate and cure every carrier case in a large body of men, but much can be done by the careful use of fly-proof latrines and covered receptacles. With an efficient system of fly and fæces destruction and arrangements for the prevention of flies coming into contact with excreta, there is every reason to believe that amœbic dysentery as well as many other intestinal disorders would be very materially reduced, if not entirely eradicated.

The work detailed in the above report was carried out at the laboratory of the section of the General Hospital.

[1] In a test subsequently carried out it was found that free chlorine in water at a strength of 1 in 10,000 failed to kill the cysts after several hours' exposure.

GAS GANGRENE AS SEEN AT THE CASUALTY CLEARING STATIONS.

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Gas gangrene is still a very striking feature in the surgery of this War. It has from its very frequency ceased to arouse very much wonder and is I think a little in danger of being accepted as a necessary evil and treated by routine measures.

Two very interesting papers have recently appeared by D'Este Emery and Kenneth Taylor.

D'Este Emery's views seem to be as follows: The toxin kills the leucocytes which are the natural protection of the body. To have a sufficient supply of these it is necessary that the circulation be intact. Therefore tissue devitalized by trauma, by constriction of the limb or by actual damage will favour the disease. Why, however, does the disease not stop when healthy tissue is reached? The explanation lies in the fact, that the toxin when present in large amount inhibits emigration and kills the leucocytes. If there is no free escape the toxin accumulates to such an extent that it soaks through into the healthy tissue and kills the defensive leucocyte and so the gangrene spreads.

Taylor's view may be summarized as follows: The mechanical action of the pressure produced by the gas is usually if not always the most important part of the infection. It brings about the death of the tissues from (*a*) the resulting anæmia, (*b*) the actual mechanical fragmentation of the muscle substance, (*c*) the mechanical scattering of the infection. He shows in the earlier part of his paper that the experimental injection of the exo-toxin produces softening of muscle and parenchymatous degeneration of the liver cells. His experiments in vitro show the same effect on pieces of muscle. He suggests that the rapid systemic intoxication is produced by the breaking down of the muscle substance, as injection of the exo-toxin does not produce an effect comparable to that seen in the clinical course of the disease.

If one compares these two theories of the disease one finds that they mainly differ in the part played by the gas. Taylor thinks that it plays an important part; D'Este Emery denies this and believes that the bacterial toxins are the important factor. Taylor believes that the disease is mainly one of the muscles. D'Este

Emery thinks that this is a mistake and that it is only the fact of the bacteria being able to produce gas by the aid of the muscle sugar that leads to this assumption.

These views reflect two somewhat different conceptions of the disease, but it seems probable that both observers have some right on their sides.

I have thought that a statement of some of the features of the disease as it presents itself to me may be of interest. I will commence by quoting some cases that illustrate some points that I want to emphasize.

Case 1.—A soldier (under care of Captain Anderson) was hit by a shell fragment, which made a large wound involving the adductors and hamstrings and smashing the femur in the upper third.

The superficial and deep femorals were injured and had to be ligated. The wound, which was a large open one, was cleansed and drained in the ordinary way. The limb was fixed in a Thomas's splint.

Within thirty-six hours the leg was dead, but non-tympanitic; the thigh was tympanitic over all its circumference. It was still warm, as such infected limbs often are, about the seat of the actual injury. No crepitation could be obtained by palpation, but with a stethoscope distinct crackling could be detected on passive motion of the limb and on relaxing or increasing deep pressure; the stethoscope was applied over the vastus externus. The limb was removed through the fracture, but the patient died quietly in his sleep some twelve hours later.

An examination of the ablated limb showed the following condition:—

The subcutaneous tissue appeared normally yellow in its fatty layer and no gas could be demonstrated by pressure. The deeper layer immediately over the fascia lata was œdematous, but not discoloured. On incising the fascia lata, which appeared normal, a similar œdematous condition of the areolar tissue over the vastus externus was observed. No gas could be demonstrated here. The vastus externus was normal in colour and contracted in a lively manner when pinched or when cut with a knife.

The adductor longus was of a dirty brick-red colour, more opaque and less translucent than healthy muscle. It was non-contractile and gave no sign of life when pinched. It was non-crepitant to the squeezing finger and cutting scalpel.

The hamstring muscles were the same colour; non-contractile and frankly gaseous and crepitant.

The areolar tissue was œdematous and infiltrated with blood, but not black.

Cultures were made from portions of the vastus externus and adductor longus by taking pieces from the heart of the muscle after searing the surface.

Both showed anaerobic bacteria as reported by Captain Emrys Roberts.

Pieces of muscle taken from vastus externus, adductor longus and biceps were examined microscopically by Captain McNee, Captain E. Roberts and Lieutenant Dunn.

(1) *The Vastus Externus.*—The fibres were normal and no bacteria were to be seen in the tissues.

(2) *The Adductor Longus.*—The fibres had lost their transverse striation. The muscle substance was broken up in transverse plates or presented longitudinal markings as if painted with a coarse brush. Between the fibres, which were obviously separated from one another, were bacteria in varying quantities in the inter-fibrillar spaces. There were some polymorphonuclear leucocytes.

(3) *The Biceps.*—The appearances were similar to those seen in the adductor longus, but the separation of the fibres was more marked and there were more bacilli and leucocytes.

Case 2.—A man under the care of Major Cuff was hit with a shell fragment in the middle of the leg. The anterior tibial was divided and was tied. (The man was also wounded in the liver and cœliotomy performed to stop the bleeding.)

About forty-eight hours after the receipt of the injury the leg became tympanitic and died. The skin of the thigh was crepitant and the gas in the crepitant area could be displaced by pressure in the same manner that surgical emphysema can be.

An incision in the crepitant area showed normal-looking fat without œdema and the knife drawn over the deep fascia gave the typical hollow sound. The subfascia connective tissue contained gas. A culture taken from this locality remained sterile.

The leg was taken off through the knee. The thigh never gave any sign of infection, although it was crepitant. A good recovery followed.

Case 3.—Pte. B. was wounded in the thigh with a shell fragment. The femoral was exposed in the wound. The thigh became typanitic on the fourth day and was treated with incisions which arrested the gangrene. The foot died in the following night, and the leg was tympanitic in the morning. Exploration showed that the femoral had become thrombosed. The leg was amputated

at the seat of election. Examination of the ablated part showed the following condition :—

It was drummy, but not crepitant.

The anterior tibial muscle group was a dirty red colour and non-contractile. The posterior tibial muscle group was brick-red, but non-crepitant. The calf group was contractile and purple. The fascial planes between the muscles appeared normal. The subcutaneous tissue in the cut surface of the amputated leg was œdematous and greenish, but contained no gas.

Cultures from the subcutaneous tissue and the purple contractile calf groups both gave *Aerogenes capsulatus.*

Case 4.—A man was wounded on the flexor aspect of the forearm. He exhibited all the signs of "gas infection." The hand was warm but anæsthetic. Incisions through the deep fascia arrested the disease, but the superficial flexors sloughed; otherwise the man made a good recovery.

Case 5.—A man was shot through the flexor aspect of the forearm. The bones were intact. He was admitted with a tense swollen forearm. The hand was cold and senseless and showed a line across the back of the hand, suggesting that the outer half of the hand was about to mortify.

Incisions into the flexor aspect of the forearm and into the thenar eminences showed the superficial muscles and those of the thenar eminences in a state of "? death." That day the hand was warm and the circulation returning. The improvement was of short duration and the hand and flexor muscles were ablated. The extensor muscles were uninfected. The man made a good recovery.

Case 6.—A man was shot through the middle of the humoral biceps. He developed all the classical signs of gas gangrene. The medical officer in charge thought that amputation would be necessary. The surgical specialist (Captain Neligan), however, made a long incision over the muscle and found that the muscle was dead and gaseous in the middle at the site of the wound. The two ends of the muscle were still normal in colour and contractile. The whole muscle was ablated.

There was some doubt as to the state of the triceps, but an incision through the fascia showed that this muscle was healthy and contractile.

Case 7.—A patient hit in the buttock suddenly developed gas gangrene in this region. It was freely incised. Before death, which occurred within a few hours, the upper arm became crepitant to the finger, though there was no wound at all in this region.

Case 8.—The case quoted by Captain Mullally and McNee in the *Lancet*, April 1, 1916, where gas gangrene appeared at the sites of subcutaneous injections.

Case 9.—A case quoted by Lieutenant-Colonel Gordon Watson, where the opposite thigh to that injured became distended with gas shortly before death.

Case 10.—Many cases in which after amputation one muscle is found in the stump dead and gaseous and separable from the others if the insertion or origin is divided.

Case 11.—A man was shot through the popliteal space. The leg was cold and dead, but was not drummy or crepitant. Amputation through the knee was performed. The popliteal space was full of blood. There was a large hole in the artery.

A dissection of the ablated leg showed that the muscles were non-contractile, but purple in appearance.

Microscopical sections showed the normal striation of the fibres which were not separated from one another.

My own impressions of the disease as seen at the Front and gathered from the cases above quoted and many others may be briefly stated as follows:—

(1) It is rare to meet gas gangrene without a muscle injury.

(2) It is chiefly a disease of the muscles and is rarely dangerous unless muscle is involved.

It occurs, it is true, in retroperitoneal hæmatoma; but here there are wounded muscles in which it can at first obtain a lodgment, and there is in addition the blood-clot and the tissues devitalized by the extravasated blood in which it can spread.

It has been said that one of the most remarkable features about *Aerogenes capsulatus* is the fact that a bacillus usually but little pathogenic becomes suddenly extremely virulent.

Barger and Dale have shown that an allied bacillus—the *Vibrio septique*—becomes at once extremely toxic when grown on muscle. Cannot then the difference in the toxicity of the *Aerogenes capsulatus* depend on the nature of the medium in which it is implanted? Will not this account for the difference in the clinical course of many wounds? If inoculated in fascial tissues it finds difficulty in establishing itself, but if it gains entrance to muscle it finds itself in favourable surroundings and is at once enabled to produce such toxins as will quickly destroy its host.

(3) The lesion in its early stages may be described as a longitudinal one, running up and down the wounded muscles from the seat of the lesion (see Case 6). Muscles and groups of muscles are involved while others escape.

(4) It is rare to find all the muscles of a segment of a limb involved, save in a segment distal to one in which the main blood supply has been cut off. Thus the whole leg dies and becomes gaseous when the femoral artery has been blocked in the thigh.

(5) The muscles affected are in the first instance the wounded ones. If the pressure caused by the disease is relieved, the gangrene will most probably be confined to these muscles, but if the pressure is not relieved the other muscles may so have their blood supply checked as to fall victims to the infection.

(6) Muscles contained in rigid compartments such as the anterior tibial group are especially prone to die if wounded.

(7) There is but little tendency for the infection to pass from one muscle to another. This is well shown in amputation stumps, where one muscle dies and becomes gaseous, while the rest of the cut muscles remain healthy.

(8) The infection is farther advanced in the muscles than in the intermuscular areolar planes.

In legs amputated for gas gangrene the only visible abnormality may be the brick-red colour of the dead muscles. So normal looking may be the appearance of the cut surface of the limb that I have known people unacquainted with the peculiarities of the disease express unbelief in the infection of the limb until the bacilli were demonstrated in the non-contractile muscle. Again, the internal appearance of a limb affected with gas gangrene is quite different to that of such a disease as cellulitis of the neck, in which the areolar tissue is infected and the muscles normal.

(9) The muscles become resonant from the presence of gas long before they become crepitant to the finger, though this phenomenon may be perceptible at an early date by means of the stethoscope. This was pointed out to me by Captain Maybury.

(10) The presence of gaseous crepitation does not necessarily mean microbic infection (see Case 2).

(11) Crepitation is usually a comparatively late phenomenon and is due to the escape of gas into the areolar and subcutaneous tissue.

(12) In an infected limb, a vascular lesion will be followed by the death of the muscle or muscle group, which death would not have followed in an uninfected limb. It is believed that the pressure produced by the gas so raises the tension in the limb as finally to arrest the circulation.

(13) In an infected limb there are several conditions of the muscles: (*a*) Normal purple red contractile muscle which may or

may not be infected as judged by cultural experiments. (*b*) Dead, non-contractile, non-crepitant muscle which has a peculiar red colour and is less translucent than normal muscle. (*c*) Dead, non-contractile, crepitant muscle which has the same appearance as the last. (*d*) Brown, black or diffluent muscle.

[Muscle dead from the cutting off of the blood supply is a purplish brown and its naked-eye appearance quite different from (*b*) and (*c*).]

(14) The microscopic appearances of muscle dead from cutting off its blood supply are different to those of a muscle dead from infection. The striation is present in the former and absent in the latter.

(15) The bacteria are between the muscle fibres and not in them.

(16) Microscopical examination suggests that the gas may find its way between the muscle fibres in front of the bacterial invasion.

(17) In dead infected muscles the fibres are separated from one another. This separation is more marked in muscles that are crepitant than in those that have not yet reached that stage.

Death of a Muscle with an Intact Blood Supply.

A muscle deprived of its usual blood supply, or with a restricted supply, falls an easy prey to the gas bacillus. Muscles with an intact blood supply seem liable to die, but the method of their death is not quite clear. Cultures show that normal looking and contractile muscle may be infected. What proportion of such infected muscles would ultimately die if left untreated is not known. Nor is the way in which the infection spreads known.

Case 6.—Shows that the infection and death spreads in both directions from the seat of injury, for in this case the centre of the muscle on both sides of the wound was dead but the extremities were still living and contractile. Small bomb or shell wounds which would not affect the main blood supply are followed by gas gangrene, and experience shows that if left untreated such infection will spread rapidly and compass the death of the wounded muscle. Incisions will save this spread of gangrene. It seems, therefore, that pressure is a great factor, but whether it wholly acts by cutting off the blood supply or by allowing the gas to penetrate the muscle and produce an anæmia of the fibres, or by favouring the penetration of the yet living muscle by the toxins derived directly or indirectly from the bacilli, is yet undetermined. In the first instance, the infection is possible because the local damage affords

a medium in which the bacteria can grow and multiply. The extension is brought about in two ways.

(1) *The Toxins produced by the Bacteria.*—One of the most striking things seen in microscopic sections of muscles dead of gas infection is the loss of striation and the breaking up of the muscle fibre substance. These appearances are quite different from those seen in uninfected dead muscle. . There must be some cause for this difference.

In some microscopic sections of an infected muscle one can see all stages of the change from normal striated fibres to the totally disorganized. The appearances are seen in sections in which the bacteria are scanty or absent and in which the amount of the separation of the fibres—presumably by gas—varies in great degree. The change in the muscle fibre may; therefore, be due either to some toxin produced directly or indirectly by the bacteria.

Both D'Este Emery and Taylor seem disposed to credit some action to this source. Taylor is of the opinion that the bacterial exo-toxin is not powerful enough to account for the constitutional symptoms and suggests that these are due to toxin produced by disintegration of the muscle substance by the bacterial toxin. He does not suggest it, but it seems possible that the toxic muscle substance produced in the traumatized portion of the muscle may be carried into the more distal parts of the muscle and cause its death.

(2) *Parts played by the Gas.*—These may be divided into two categories: (*a*) The part it plays within the limb; (*b*) the part it plays within the muscle.

One of the most striking and most important signs of gas infection is the tense and tympanitic state of the limb and the rapidity with which this condition is reached.

There is nothing but the rapid evolution of gas that could bring about such a condition in so short a time. An incision into such a limb shows that the increased tension is caused by the swelling of the muscle due to the gas within it. There may be gas in the areolar planes, but this is not usually the case to any degree. It has been pointed out that a muscle may be dead and full of gas and yet not crepitant to the finger ; if, therefore, crepitation is taken as the criterion of gas infection a mistake may be made and a gaseous muscle passed as a non-gaseous one.

When the gas is present in the areolar tissue it follows the path of least resistance and finds its way along the intermuscular planes and around the vessels. It will disseminate itself into the subcutaneous tissue a considerable way from the wound.

It has been stated above that in a segment of a limb that has been wounded it is only the wounded muscles that yield to the infection in the first instance. The injured muscles will induce a deleterious effect on the uninjured one by raising the intrafascial pressure of the limb, and thus causing pressure on the blood-vessels and consequent checking of the circulation. Even if the areolar planes are grossly infected they cannot influence the pressure in the limb, since the muscle sugar is necessary for the production of gas.

Taylor is of the opinion that the pressure of gas within the muscle itself leads to disintegration of the muscle-fibre substance.

The pressure produced by the gas will in addition tend to drive the toxins into the circulation, and thus be a factor in the production of the systemic poisoning and lowering of the resistive power of the body.

D'Este Emery, in combating Taylor's contention that the gas production plays an important part in the disease, says: "Gangrene may occur and the patient may die without the formation of any gas in the tissues." This statement is opposed to what is seen of the disease in the Casualty Clearing Station. The great sign on which reliance is placed is the swollen and tympanic condition of the limb, usually preceded by constitutional symptoms. What can cause such sudden swelling unless it be gas? In such cases there is no crackling or crepitation to the finger palpating the skin. An examination of the muscles that have suffered the "red death" may even yet reveal no crepitation, but microscopic sections of such non-crepitant muscles show the fibres separated from one another and the spaces often free from leucocytes and bacteria.

Men who die of the effects of gas gangrene in the casualty clearing stations die before there is any marked suppuration. It may be that the suppuration and involvement of the fascial planes is seen after the patients have left the Front, being a later manifestion of the disease.

The Path of the Infection, when an Unwounded Segment of a Limb from which the Blood Supply has been cut off becomes infected.

When a muscle has been wounded the method of infection is obvious. The path of the infection is not so obvious when there is no wound. For instance, the leg below the knee will become infected when the femoral vessels are occluded, although there is

no wound in the leg proper. There seem to be three possible avenues :—

(1) Direct extension.

(2) Extension along the blood-vessels.

(3) Systemic infection.

(1) The anatomical appearances do not favour this route. The only muscular tissue that crosses the knee is contained in the two heads of the gastrocnemius. It has been pointed out above that direct extension to an intact muscle is rare, and as a matter of fact the soleus and gastrocnemius are the last muscles to become infected and die. The appearance of the fascial planes does not suggest them as the path.

(2) Possibly the infection travels inside the vessels—just before or after the circulation has ceased, the open ends of the vessels on the infected wound being the starting point. H. Dunn has found the aerogenes bacilli in the clotted vessels in the brain after a wound of the carotid artery.

(3) Mullally and McNee have pointed out that gas formation may take place at the sites of subcutaneous and saline injections, the slight trauma being sufficient to afford a resting-place for the bacteria circulating in the blood. Case VII and Case IX above quoted point in the same direction. It is, therefore, possible that bacteria in the blood are implanted in the distal segment of the limb before the circulation is quite brought to a close. It may be that they first gain a footing in the muscles mostly affected by the cutting off of the main blood supply and by the production of gas within them finally and completely arrest the blood-stream.

Conclusions as Regards Treatment.

(*a*) The circulation should be helped in every way. It is unnecessary to insist on the bad effects of tight bandages and tourniquets—they are appreciated now by all. Tension in a limb due to blood effusion should be relieved, no matter how small the wound. Bleeding from a small branch may produce pressure on the main vessel and even without this may cause such pressure as to embarrass the circulation. In cases where hæmorrhage into a limb is continuing there is no doubt as to the advisability of finding the bleeding point. If the artery is a main one an attempt should be made to suture instead of to ligate the vessel.

Suture also would seem to be worth trying when a main vessel is locally thrombosed from the effects of trauma. If there is

difficulty in bringing the cut ends of the vessel into apposition a Tuffier's tube may be tried.

Injuries of the popliteal artery are so uniformly followed by gangrene, if the vessel is ligated, that every means should be tried to re-establish the lumen, even if for a few hours.

In the case of circumscribed arterial hæmatoma accompanying a small wound of the limb, time alone can show if an attempt to suture the artery is good. One should most probably be guided by the state of the circulation in the distal portion of the limb.

(*b*) In dealing with gas gangrene in a wounded segment of a limb and deciding on the advisability of amputation, it should be borne in mind that it is usually only the wounded muscles that become gaseous, and that incision or ablation of such muscles is often sufficient to arrest the disease and stop the infection (see Case 6).

In the case of the thigh the ablation of muscles may present difficulties, but in the leg this part of the limb can often be saved by the ablation of the anterior tibial group, and the same applies to the muscles of the forearm. The brick red colour and the non-contractility will show at once which muscles are past saving.

(*c*) When gas gangrene occurs in a segment of a limb distal to the segment wounded it nearly always means that the main artery is blocked and amputation of the gangrenous segment is the only course.

(*d*) The presence of crepitation in tissues apart from other signs is of no special importance. A limb should not be sacrificed on account of crepitant skin (see Case 2). The state of the muscles and the number dead should be ascertained before amputation is performed, otherwise a limb or a very considerable portion of its length may be sacrificed unnecessarily.

The disease is the great bugbear of the surgeon at the Front. It involves much labour and complicates the evacuation of the wounded. It occurs in all sorts of wounds, whether small or large, and with all sorts of projectiles. There is no wound, however insignificant, that one can feel happy about if not opened up. It is true that the disease is not so dangerous now as it used to be, because of the universal opening up of wounds, but the amount of trouble that it entails, and the amount of disturbance that it is necessary to inflict on a grievously wounded patient, makes one long for some remedy other than surgical interference.

STATISTICS RELATIVE TO THE FIRST THOUSAND CASES OF DISEASES OF THE EAR, THROAT AND NOSE, TREATED IN THE FOURTH SCOTTISH GENERAL HOSPITAL, STOBHILL, GLASGOW.

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The object of this short paper is to show the frequency and nature of the diseases of the ear, throat and nose met with in a T. F. General Hospital.

The cases referred to here had all been admitted to the hospital. In addition, a considerable number of outdoor cases were treated, or examined with reference to pension or discharge from the Service: these have not been included in the statistics.

The hospital was opened on August 12, 1914, but no cases came under my care until September 23. The thousandth case was seen n January 21, 1916.

The proportion of oto-rhino-laryngological cases to the total admissions to the hospital for the year 1915, during which the working conditions might be regarded as normal, was as follows:—

Total admissions	8,684
Cases of ear, nose and throat disease	866 = 9·97 per cent.

Both totals include readmissions: those of ear, throat and nose patients amounting to 48. The readmissions to the hospital probably form about 5 per cent of the total admissions, but their exact number could be summed up only with considerable trouble.

It should be pointed out that the thousand cases on which these statistics are based do not represent the total number of cases of disease of the ear, nose and throat admitted to the hospital between the above mentioned dates. The series does not include cases treated by the physician or surgeon in whose ward they lay, but which were not seen by me.

In estimating the frequency of the individual diseases met with, readmissions have been left out of account, and a thousand consecutive new cases utilized.

Of the thousand cases, 731 were admitted to hospital on account of an affection of the ear, throat or nose. The remaining 269, when admitted, were suffering from a disability other than that for which I was consulted. The latter group includes most of the less important ailments, also those in which an examination was requested for suspected disease, but none found (classed as "No appreciable disease").

	Total cases	Disability present prior to enlistment	Unfit for general service
(7) *Tuberculosis*—			
Nose (lupus)	1	1	1
Pharynx (acute)	1	1	(died)
Larynx	1	1	1
(10) *Diphtheria*—			
Paralysis of palate	2	—	—
(42b) *Syphilis (Secondary)*—			
Pharynx	6	3	—
Syphilis (Tertiary)—			
Nose	1	1	—
Nose and mouth	2	1	—
Pharynx	8	5	1
Pharynx and Larynx	1	—	—
(21) *Influenza*—			
Sore throat	5	—	—
(37) *Rheumatism*—			
Sore throat	4	—	—
(127) *Vertigo*—			
(b) Auditory	2	1	1
(133) *Hysteria*—			
Dysphagia	1	—	—
Aphonia	1	—	—
(234b) Dacryocystitis	3	1	—
	39	15	4
Ear—			
(259a) Acute inflammation of auricle or external auditory meatus	5	—	—
(259b) Chronic inflammation of auricle or external auditory meatus	9	2	1
(259c) Suppuration (abscess) of auricle or external meatus	4	—	—
(264) Accumulation of wax or epidermis	39	—	—
(265a) Acute inflammation of middle ear	15	—	—
(265b) Chronic inflammation of middle ear	48	42	22
(265c) Suppurative inflammation of middle ear	273	198*	85
(266) Perforation of membrana tympani	11	9	4
(270) Obstruction of Eustachian tube	34	—	—
(265b and 271b) Chronic inflammation of middle ear with involvement of internal ear	5	5	1
Injury to internal and middle ear	33	14†	15
(275) Tinnitus	1	1	—
(1128) Wound of membrana tympani	1	—	—
(1129 Foreign body in ear	2	—	—
Gunshot wound of ear	4	—	4
Total aural cases	484	271	132

* The present attack had set in, or previous attacks had taken place, prior to enlistment.

† Various forms of ear disease had been present prior to enlistment, and had rendered the ear more susceptible to damage.

	Total cases	Disability present prior to enlistment	Unfit for general service
Nose—			
(962) Eczema of nasal vestibules	4	—	—
(277a) Acute rhinitis	1	—	—
Rhinitis sicca anterior	2	—	—
(277b1) Hypertrophic rhinitis	92	56	—
(277b2) Atrophic rhinitis	1	1	—
(277b3) Ozæna	2	2	—
(278c) Abscess of septum	1	—	—
(278g) Deviation of septum	34	32	—
Soft fibroma (polypus)	6	3	—
Papilloma of nasal vestibule	1	—	—
Rhinolith	1	1	—
(280) Epistaxis	19	9	—
(283b) Suppuration in accessory sinuses of nose	6	4	—
Naso-antral polypus	2	1	—
Foreign body in antrum	1	—	—
(284b) Chronic inflammation of naso-pharynx	1	—	—
(285) Adenoid vegetations	15	15	—
Gunshot wound of nose	4	—	—
Total nasal cases	193	124	—
(338) Asthma	5	5	—
Larynx—			
(339Aa1) Acute laryngitis	18	—	—
(339Aa2) Chronic laryngitis	12	—	—
(339Ba) Œdematous laryngitis and pharyngitis	1	—	—
(349) Laryngeal paralysis	5	2	1
Laryngeal growth	1	—	—
Gunshot wound of larynx	5	—	1
Total laryngeal cases	42	2	2
Mouth, Palate and Fauces—			
(436b) Vesicular stomatitis	1	—	—
(437) Ulcerative stomatitis	1	—	—
(439) Necrosis of jaw	1	1	—
(450) Dental cyst	4	—	—
(451) Inflammation of gums	1	—	—
(473) Sore throat	46	7 (susceptible)	— —
(474) Ulceration of palate and fauces	2	—	—
(475a) Follicular tonsillitis	26	8 (susceptible)	— —
(475b) Suppurative tonsillitis	19	6 (susceptible)	—
(476) Hypertrophy of tonsils	72	49	—
(477) Elongated uvula	1	1	—
Abscess of lateral wall of pharynx	1	—	—
Gunshot wound of palate, etc.	1	—	—
Total diseases of pharynx, etc.	176	72	—

	Total cases	Disability present prior to enlistment	Unfit for general service
Mouth, Palate and Fauces—continued.			
(615) Hypertrophy of lymphatic glands of neck	2	—	—
Gunshot wound of neck	1	—	—
(638) Enlargement of thyroid	1	1	—
Carcinoma of œsophagus	1	—	Died
Speech defects..	2	2	—
Gassed	10	—	—
No appreciable disease	44	—	—
	61	3	—
Totals	1,000	492	138

The diseases have been classified according to the nomenclature of the Royal College of Physicians of London. A list of the diseases is subjoined together with their respective totals, also the number of cases in which the disability was present prior to enlistment, and the number that were unfit to return to general service.

Notes on Cases.

Tuberculosis.

Lupus of the Nose.—Part of the right ala and septum were destroyed, and as the disease was still active the man was discharged from the Army.

Acute Tuberculosis of the Pharynx.—Sore throat began a few days before mobilization; in trenches; went sick on November 2, 1914; examined by me on November 13, 1914, and then found to have superficial ulceration of the faucial pillars, soft palate and uvula; tubercle bacilli in swab; died, December 20, 1914.

Laryngeal Tuberculosis.—Slight case; discharged from Army.

Diphtheria.

Regurgitation of fluids by nose and history of recent sore throat in both cases.

Syphilis.

Secondary.—Three of the six patients contracted the disease after enlisting.

Tertiary.—Twelve cases, one in which the soft palate was adherent to the posterior pharyngeal wall was almost certainly hereditary. One patient was discharged chiefly because of epilepsy.

Vertigo, Auditory.

In one case the man had received a bullet wound on the crown of the head; he complained also of double vision. In the other

case, previous to enlisting, he had had three mastoid operations. Having succeeded in concealing his aural disability he was drafted to the Dardanelles, where the gunfire at once produced vertigo and vomiting, so that he had to be sent home after having been only a few days on duty.

Hysteria.

The case of hysterical aphonia was of interest in that the laryngeal appearances were those of organic disease. The man, aged 28, while at the Dardanelles, was wounded on July 12, 1915, by a bullet which entered one inch in front of the right ear and emerged two inches behind and below the lobe of the ear. He was sent home and I saw him on October 3, owing to his having become aphonic a week previously. On examining the larynx, the right vocal cord and arytenoid were found to be motionless in, or about, the cadaveric position, while the left cord moved normally. Lieutenant-Colonel Middleton found nothing in the chest to account for the apparent complete paralysis of the right recurrent. Captain Riddell, by X-ray examination, discovered evidences of considerable fibrosis of the upper half of both lungs. The larynx was examined every two or three days but the appearances remained unchanged for a fortnight, when slight movement was detected in the apparently paralysed right cord. At the next examination the movement of the right cord had improved, while that of the left—which hitherto had been perfect—was defective. At subsequent visits, the cords presented various degrees of mobility, or immobility; the most frequent aspect, however, was that of complete recurrent paralysis of the right cord. The exercises in breathing and phonation which I am in the habit of using for hysterical aphonia seemed to aggravate the immobility. A laryngeal electrode, without current, was passed between the vocal cords, and at the first sitting perfect approximation and the normal voice were obtained.

Chronic Inflammation of Auricle and External Auditory Meatus.

In this class are included cases of chronic eczema of the external meatus. Some of these have proved very intractable, and even after long residence in hospital have been sent out not altogether cured; one of the cases had to be discharged. As exposure to cold and wet is liable to aggravate or cause a recrudescence of the affection it might be better if such patients were put on home service or discharged.

Accumulation of Wax or Epidermis.

This class also contains a few cases in which the ears were filled with earth, the men having been buried in a trench or dug-out. It is surprising how many men from the Front have large collections of cerumen.

Acute Middle Ear Inflammation.

The right ear was affected in eleven cases; the left ear in four cases. Four of the patients had had previous attacks.

Chronic Middle Ear Inflammation.

Of the total number of cases of this class (forty-eight), in only six was the deafness said to have begun after mobilization or enlistment. In some there had been otorrhœa in childhood and deafness since; in others the deafness was attributed to working amidst noise in ship yards or engineering shops. In forty cases both ears were affected; in three, the right ear only: and in five, the left ear only. The symptom complained of by all the patients was deafness. Treatment affected appreciable improvement in the hearing of about a third of the patients. In twenty-two instances the deafness was of such a degree as to unfit the man for general service. Of these, eight were discharged from the Army, six were placed on light duty, and eight on home service.

The deafness handicaps especially in hearing commands, in transmitting whispered orders at night in the trenches, on sentry duty, and on approaching the sentry. One of the patients in this class was fired at—and missed—by a sentry whose challenge he had failed to hear and answer.

Suppuration of the Middle Ear.

Suppuration of the middle ear has been the most frequently occurring disability. The cases, amounting to 273, form twenty-seven per cent of the total.

Some of the cases in which the discharge was scanty, but the deafness considerable, might fall more correctly under "Chronic Inflammation of the Middle Ear"; others, in which suppuration and deafness followed shell fire, ought perhaps to be grouped with those of injury to the internal ear. In all of them, however, the suppuration primarily called for treatment and its presence or absence has been made the basis of classification.

The conditions complained of were as follows :—

Otorrhœa	200 cases
Deafness	52 ,,
Earache	12 ,,
Polypus in ear	3 ,,
Vertigo, 2; headache, 2	4 ,,
Mastoid swelling, 1; tinnitus, 1	2 ,,

Inquiry was made in each case as to whether discharge had ever taken place prior to mobilization or enlistment, with the following results :—

Otorrhœa had occurred previous to joining the Army in ..	198 cases
,, ,, been noticed only since joining the Army in	72 ,,

The few remaining cases were doubtful.

The discharge came from the right ear in	95 cases
,, ,, ,, ,, left ,, ,, ...	107 ,,
,, ,, ,, ,, both ears ,, ...	71 ,,

The total number of discharging ears was thus 344.

The following conditions were found associated with the otorrhœa :—

Aural polypi or granulations	100 ears
Cholesteatoma	5 ,,
A large perforation incapable of closing	44 ,,
A dry permanent perforation in the other ear	15 ,,
Attic suppuration	16 ,,
Suppuration continuing after old mastoid operations ..	17 ,,

The suppuration was treated for varying periods and, when not cured, instructions were given as to keeping the ears clean; the men were also warned as to the risk of recurrence of otorrhœa when permanent perforations were present.

When discharged from the hospital the following was the state of the ears :—

Otorrhœa still present (including cases seen only once) ..	212
,, had ceased and perforation healed	96
,, ,, but ,, remained	36

The decision as to the disposal of the patients was influenced by various considerations, e.g., the amount of discharge, tendency to recurrence of granulations, symptoms of retention, amount of deafness, duration of otorrhœa, length of military service. In almost all the cases discharged from the Service there was either marked deafness, insufficient drainage with unwillingness to submit to operation, or very unhealthy ears in a recent recruit. In those put on light duty their cases were still *sub judice* and they were afforded a further period of probation. Those put on home service had

had their ears damaged while at the Front, or presented features suggesting the not unlikely development of serious complications.

The 273 cases were disposed of as follows :—

Discharged from Army	25
Light duty	11
Home service	49
Returned to duty	188

Before leaving suppuration of the middle ear special reference should be made to twenty-six cases (included in the above statistics) in which the otorrhœa was said to have been produced or markedly aggravated by gunfire or shell explosion. The seriousness of the damage from this cause is indicated by the fact that only half of the patients were afterwards fit for general service, while the other half had to be disposed of as follows: Discharged, three; light duty, two; home service, eight.

The presence of ear disease would seem to predispose to further damage when under fire, for, of the twenty-six cases, sixteen had had an affection of the ears previously, and of the thirteen who proved unfit for general service every case had a history of old ear disease. This connexion is referred to further under "Injury of Internal and Middle Ear."

Perforation of Tympanic Membrane.

In eleven patients a dry perforation of one (eight cases) or both (three cases) tympanic membranes was found to be the cause of the symptoms complained of (deafness most frequently). In only two cases did the history point to the disability having been produced subsequent to enlistment. The destruction involved at least half of the tympanic membrane in most instances. Seven of the men returned to duty, one was placed on home service, one on light duty, and two were discharged from the Army.

To the above cases should be added those referred to under "Suppuration of the Middle Ear," in which one ear presented a dry perforation (fifteen cases), and those in which after cessation of the otorrhœa a perforation remained (thirty-five cases). In 1,000 patients, therefore, at least sixty-one had a permanent dry perforation of one or both tympanic membranes when last examined.

Obstruction of Eustachian Tube.

Deafness was found to be due to Eustachian catarrh in thirty-four cases. Colds, bathing and rifle fire were the causes assigned. All of the men were sent back to duty.

Chronic Inflammation of Middle Ear with Involvement of Internal Ear.

This class contains five cases in all, of which pronounced deafness, due chiefly to an affection of the internal ear, was an outstanding feature. In all of the patients deafness was present before enlistment—in three instances it was attributed to a noisy occupation—and was little, if at all, aggravated by military service. One man was put on light duty, the other four were returned to ordinary duty.

Injury of Internal and Middle Ear.

In thirty-three cases deafness due to injury of the internal and middle ear was produced or greatly aggravated in consequence of active service. The causes assigned for the deafness were gunshot wound close to ear (nine), gunfire overhead, shell bursting in trench or near ear, thrown up in air, fall on head, and buried in dug-out.

Both ears were affected in seventeen cases; the left in eleven, and the right in five.

Otorrhœa was stated to have taken place in four cases after the accident, but had ceased before the patient came under observation.

The relative degree of involvement of the middle and internal ear varied considerably in individual cases. A rigid classification was inadmissible in the majority of the patients owing to the disability having been comparatively recently acquired and pathological changes not having come to a standstill, Several of the patients near whom shells had burst lost their hearing completely for days and then recovered it gradually in one or both ears; some of these cases would be more correctly classified under "Concussion."

DISPOSAL OF CASES IN WHICH THE EAR WAS DAMAGED BY GUNFIRE, ETC., SHOWING INFLUENCE OF PREVIOUS EAR DISEASE.

		General service	Home service	Light duty	Discharged
Injury of internal and middle ear (33):—					
(*a*) Without previous ear disease	(19)	14	2	1	2
(*b*) With „ „	(14)	4	3	1	6
Suppuration of middle ear, etc. (26):—					
(*a*) Without previous ear disease	(10)	10	—	—	—
(*b*) With „ „	(16)	3	8	2	3

Previous ear diseases undoubtedly aggravate the effect of the injuries under consideration. Of the thirty-three patients, nine admitted a certain amount of deafness previously and five had had otorrhœa. Of these fourteen, only four were fit to return to general

service; while, of the nineteen who gave no history of old ear trouble, fourteen were sent on general service. The following table shows the mode of disposal of these cases, and of the twenty-six cases of suppuration of the middle ear due to gunfire already referred to; the fifty-nine cases have many points in common.

Gunshot Wounds of Ear.

Case 1.—Bullet entered at outer angle of left eye, and after crossing external auditory meatus emerged behind left ear. The lumen of the meatus was reduced and bridged by a fibrous band. Necrosed bone was present beyond the bridge. Home service.

Case 2.—Piece of shrapnel entered ½ inch in front of left ear. Some bits had been removed, others were still present. Home service.

Case 3.—Bullet entered at middle of right mastoid region and emerged below left malar bone. Right otorrhœa. Paralysis of right facial and right half of soft palate. Hypæsthesia of right half of soft palate and posterior pharyngeal wall. Discharged from Army.

Case 4.—Bullet entered right temple, crossed right external auditory meatus and escaped at attachment of auricle to mastoid. Right external ear almost closed. Discharged.

Hypertrophic Rhinitis.

Under the term hypertrophic rhinitis it has been necessary to include both swelling and hypertrophy of the turbinates, as these conditions are not differentiated in the nomenclature. Ninety-two cases are included in this group; ten additional patients, who are classified under other diseases, were treated for turbinal hypertrophy.

The great majority of the patients complained simply of nasal obstruction, which, in some, caused shortness of breath while marching, in others insomnia. Headache, pharyngeal irritation, cough, and conjunctivitis were traced in not a few instances to this nasal affection.

In fifty-six men the disability was present before enlistment or mobilization; in twenty-three it was noticed only after; and in twelve the time of onset was doubtful.

Abscess of Nasal Septum.

One case, caused by boxing.

Deviation of the Nasal Septum.

In thirty-four cases marked deviation of the septum was the principal disability. In only two instances had it been produced during military service. Submucous resection was performed in thirty patients.

Soft Fibroma of the Nose (Polypus).

Six cases are included in this group. Three others, classified elsewhere, also required treatment.

Rhinolith.

One case with nasal symptoms, nucleus formed by date-stone. Another patient with suppuration of the middle ear and no complaint as to nose was found to have a good-sized calculus.

Epistaxis.

Epistaxis was complained of by nineteen men. In ten it was said to have set in after joining the Army. In none of the cases was the hæmorrhage severe, with one marked exception due to nephritis, in which the profuse and persistent flow came from a vessel on the floor of the nose. The source of the bleeding in the other cases was a varix or excoriation on the anterior part of the septum. Not infrequently the condition was maintained by intentionally fingering the nose.

Suppuration in the Accessory Sinuses of the Nose.

Antral suppuration, four cases; frontal sinus suppuration, one case; suppuration of antrum and frontal sinus, one case. The frontal sinus case was acute; one antral case had been caused by caries following a gunshot wound, and in the other four cases the disease had set in prior to enlistment.

Foreign Body in Antrum.

Piece of a root of first molar had been broken off during extraction and a discharging fistula remained.

Adenoid Vegetations.

In fifteen cases the symptoms complained of—nasal obstruction, deafness, otorrhœa—were regarded as due to adenoids, and fourteen were operated on. Other seven cases, classified elsewhere, also had adenoids removed.

Gunshot Wounds of the Nose.

Case 1.—(Already classified under injury to internal ear.) Bullet entered about middle of left side of nose, carried away upper teeth

on right side and emerged about one inch in front of and below right external auditory meatus. Septum deviated to right and perforated. Right fossa almost blocked by synechia between septum and right inferior turbinate.

Case 2.—Bullet traversed nose immediately beneath nasal bones. There is now a symmetrically placed scar on each side of the nasal bridge, the left being slightly the larger. The septum is also somewhat deviated to the left and united to the outer wall of the nose anteriorly by a small synechia.

Case 3.—Complained of inability to hold up head or to raise eyes, and lay all day huddled up in bed. He had been shot two and a half months previously in the right arm and through the middle of the bony bridge of the nose. Broad synechiæ were found between the septum and both inferior turbinates anteriorly, so that a view of the deeper parts was unobtainable. A few days later, the patient while clearing his throat expelled the metal casing of an explosive bullet measuring twenty-seven millimetres in length and twelve millimetres across the base. It was covered with black debris and had the smell characteristic of a rhinolith. He quickly regained the power of raising head and eyes.

Case 4.—Bullet injured right side of nasal bridge and caused deflection of whole nose to left.

Case 5.—Slight bullet injury.

Asthma.

Five cases were sent for nasal treatment, In all of these the patient had had attacks previous to joining the Army.

Acute Laryngitis.

Eighteen cases were met with, a large proportion of which were suffering also from acute rhinitis and pharyngitis. In two instances a small oval erosion or superficial ulcer was found on the second quarter of both vocal cords; these symmetrical white areas stood out distinctly on the red cords. This appearance is but little known probably because laryngologists have few opportunities of making an early examination of such cases.

Chronic Laryngitis.

Twelve cases of chronic laryngitis caused by exposure, gas and shouting orders. Several were aphonic, and two or three adopted a forced harsh whisper (see note under "Malingering"). All became fit for duty.

Œdematous Laryngitis and Pharyngitis.

This man had marked œdema of both lateral walls of the pharynx, of the right faucial pillar and of the epiglottis. Temperature 104° F. The disease took a favourable course and the œdema of the right faucial region was replaced by a dusky appearance as if ecchymosed, which soon cleared up.

Laryngeal Paralysis.

A bugler complained of cough, and on examination was found to have left abductor paralysis; five years previously he had had an operation for goitre. A recently enlisted man who was unable to shout his number had complete paralysis of the right cord; he had been hoarse since having pleurisy, etc., ten years before. Home service. In the other three cases the tensors, transversus or adductors were affected, but the condition quickly cleared up.

Laryngeal Growth.

One man had a papilloma on his right vocal cord.

Gunshot Wounds of Larynx.

Case 1.—Shot through neck eight days previously. Bullet entered behind the larynx on the right side and emerged at a slightly higher level on the left side. The epiglottis was swollen and red at the base and appeared as if half torn away. The anterior wall of larynx was scarred. The vocal cords were untouched.

Case 2.—Bullet entered close to vertebral border of right scapula and came to rest in front of hyoid bone, whence it was extracted. Huskiness since. Examination of larynx two months later showed that right vocal cord was represented by a smooth, narrow, red, immobile fold, between which and the left vocal cord a gap was left on phonation. Edge of right ventricular band was scarred. The thyroid cartilage felt flattened out. The bullet probably entered the larynx below the right arytenoid, passed forwards and slightly upwards and inwards to reach the middle line above the anterior commissure, carrying away in its course the right vocal cord.

Case 3.—Shot through neck. Scar on right side on a level with middle of thyroid cartilage and 1½ inch from middle line; that on left side ½ inch farther out and slightly lower. Three weeks after receiving wound voice was husky and inspiration somewhat noisy. Laryngeal mirror showed union of anterior two-thirds of the true

and false cords, so that the glottis was reduced to a rounded opening posteriorly. Discharged from the Service.

Case 4.—Shot through neck at level of cricoid cartilage. Bullet entered 2 inches to right, and emerged 2½ inches to left of middle line. Paresis of right arm. Ten weeks later the left half of the larynx was fixed apparently owing to union of the swollen ary-epiglottic fold and arytenoid with the posterior wall of the pharynx.

Case 5.—Received several wounds in head and neck; one in middle line below prominence of thyroid. Hoarse since. Small projection—like Singer's nodule—on right vocal cord. X-ray plates showed presence of small foreign body behind larynx.

Vesicular Stomatitis.

Case of herpes of the mouth and palate accompanied by a rash, the appearances in many respects resembling those of secondary syphilis. Wassermann negative. The affection cleared up in a few days.

Ulcerative Stomatitis.

This case was also suggestive of syphilis but quickly improved. Pneumococcal infection.

Necrosis of Jaw.

Discharging sinus with necrosed bone at site of extracted upper molar.

Inflammation of Gums.

The patient had spitting of blood every morning for several weeks and stated that it came from the lungs.

Sore Throat.

It is difficult to conjecture how terms such as "sore throat" came to find place in the nomenclature. Possibly they were introduced with the object of serving as convenient dumping-grounds for affections not mentioned. It is to this use that the term "sore throat" has here been put. Cases of influenzal and rheumatic sore throat have been placed under the general diseases of which sore throat was a symptom.

Forty-six cases have been collected under this heading, made up of the following groups: Catarrhal tonsillitis, sixteen; catarrhal pharyngitis, twelve; membranous pharyngitis, five; granular pharyngitis two; herpes of the pharynx, two; hypertrophy of lateral wall of pharynx, one; and eight cases in which no objective condition at fault was found.

In the cases of membranous pharyngitis the bacteriological examination threw no light on the causation. One of these patients—a chief petty officer direct from his ship—had membrane on the gums, tongue, and left faucial region, and in the course of his illness recurrent severe bleeding from the left tonsil. Scurvy could be excluded. The underlying general disease was not made out.

Ulceration of Fauces.

Two cases of Vincent's angina. One of the patients was from a Canadian regiment, amongst the men of which the disease is reported to have been rife.

Follicular Tonsillitis.

In addition to twenty-six cases notified under this title almost as many more attacks were met with in the course of other diseases. Patients who had operations on the nose necessitating packing, especially submucous resection of the septum, occasionally developed severe follicular tonsillitis. The frequency of this complication, which is rarely seen in private nursing homes, shows the advisability of providing for those temporarily deprived of the protective functions of the nose special accommodation out of a general ward.

Suppurative Tonsillitis, Quinsy, Peritonsillar Abscess.

In the nomenclature quinsy is differentiated from peritonsillar abscess, but on what grounds we do not know; here the terms are used synonymously. The nineteen cases reckoned under the above heading do not include several attacks incidental to ailments classified elsewhere, or those cases in which the removal of the tonsils was subsequently carried out. Fourteen of the nineteen cases had had at least one previous attack.

Hypertrophy of the Tonsils.

There were seventy-two cases of tonsillar hypertrophy, twenty-four of which were admitted to hospital with sore throat. Fifty-two patients stated that they were subject to sore throat. In sixty-seven cases the tonsils were removed, the method adopted—with only a few exceptions—being enucleation by dissection.

Gunshot Wound of Palate, etc.

Bullet traversed left eye, escaped beneath middle of right half of lower jaw and then entered shoulder. The left eye was removed. The patient complained of difficulty in eating owing to the food passing into the nose. The speech was almost unintelligible.

Carcinoma.

Œsophagus:—Hoarseness and dysphagia. Abductor paralysis of left vocal cord. Carcinoma at upper end of œsophagus.

Speech Defects.

One case of sigmatismus and one case of eunuchoid voice.

Gas.

Ten patients—and several others classified elsewhere—were examined especially with reference to the effects of inhaling gas. They were seen at intervals varying from eight days to five months after exposure to the fumes. The symptoms complained of were: shortness of breath, tightness of chest, cough, expectoration, hoarseness with weakness of voice and occasional aphonia, otorrhœa and deafness. Examination revealed nothing noteworthy in the nose or pharynx, and in only a few of the cases slight redness of the vocal cords.

"No Appreciable Disease."

Under this heading forty-four cases are collected in which no appreciable disease was found in the ears or upper respiratory tract to account for the symptoms complained of. The cases may be divided into two groups.

(1) Cases referred by colleagues for the elucidation of certain symptoms but in which the examination proved negative. Thus, seven patients with spitting of blood showed no sources of hæmorrhage in the upper air tract; in three patients with affections of the eyes no aggravating condition was found in the nose. Cases of headache, six; occasional aphonia or hoarseness, three; epilepsy, dysphagia, vertigo, "mastoid disease," "sore throat," etc., were also examined with negative result.

(2) Cases in which the patient stated that he was suffering from certain symptoms, but the presence of which was disproved or rendered doubtful by examination. Thus, five patients complained of deafness, three of otorrhœa and two of earache, but on inspecting the ears and testing the hearing all were found normal. One man asserted that he had a noise in his ears which was audible to others; this was found to be a clicking sound produced by voluntary contraction of certain muscles of the pharynx. Others complained of epistaxis, subjective kakosmia, etc. Almost all the patients in this group were either malingering or exaggerating the severity of their symptoms.

Malingering.

Malingering was detected chiefly in connexion with deafness, epistaxis and hoarseness.

Under "No Appreciable Disease" cases are referred to in which not only deafness but even otorrhœa was complained of, whereas the ears on examination proved to be normal. Only in one instance—that of a deserter under arrest—was complete deafness feigned; frequently attempts were made by those "working their ticket" to magnify the deafness. The man's honesty could be fairly well gauged by testing his hearing with the voice and a series of tuning-forks on several occasions; any marked discrepancies betrayed a dishonest intention.

In several instances recurrent epistaxis was assigned as a cause of inability for duty. One man had been in six hospitals previous to admission under me, and had done only one month's parade out of eleven months' service. He had merely superficial excoriations on the anterior part of the septum, which were maintained almost undoubtedly by intentional fingering.

Another symptom occasionally feigned was hoarseness amounting almost to aphonia. On setting the patient to do vocal exercises it was soon apparent that the rough whisper emitted was produced by compressing the parts. In this connexion it should be mentioned that the writer has met with several cases amongst soldiers of dysphonia spastica, an intractable affection which prior to the war was very rare. This must be distinguished from the artificially produced, forced, hoarse whisper referred to.

Cases Unfit for General Service or Invalided.

In the table on next page are grouped 138 cases which were rendered unfit for general service solely on account of affections of the ear, nose and throat. In addition to these a considerable proportion of the 1,000 cases under review has been discharged or put on limited duty by my colleagues owing to other disabilities.

The figures in brackets give the number of cases—altogether 120—in which the disability was present before enlistment.

Résumé.

(1) The oto-rhino-laryngological cases formed 9·97 per cent of the total admissions to the hospital during 1915.

(2) The commonest diseases of the ear, nose and throat in 1,000 consecutive admissions were: Suppuration of the middle ear, 273 cases; hypertrophic rhinitis, ninety-two cases; and hypertrophy of the tonsils, seventy-two cases.

(3) In 492 cases the disability itself or a predisposing condition existed previous to enlistment or mobilization. This fact suggests the advisability of examining the ears, nose and throat of recruits.

(4) Almost all the operative work was in connexion with disabilities which existed prior to enlistment, e.g., the treatment of hypertrophic rhinitis, submucous resection of the septum, and removal of tonsils and adenoids. There is no doubt that soldiers not infrequently request operations for conditions which existed for years before they joined the Army, but which they had little or no intention previously of having treated.

	Home service	Light duty	Discharged from Army
Tuberculosis of nose	—	—	1 (1)
,, larynx	—	—	1 (1)
Syphilis	—	—	1 (1)
Vertigo	1 (1)	—	—
Chronic inflammation of auricle and meatus	—	—	1 (1)
,, middle ear inflammation ..	8 (7)	6 (5)	8 (8)
Suppuration of middle ear ..	49 (45)	11 (10)	25 (24)
Perforation of tympanic membrane	1 (1)	1 (1)	2 (2)
Chronic inflammation of middle and internal ear	—	1 (1)	—
Injury of internal and middle ear ..	5 (3)	2 (1)	8 (6)
Gunshot wound of ear	2	—	2
Laryngeal paralysis	1 (1)	—	—
Gunshot wound of larynx ..	—	—	1
	67 (58)	21 (18)	50 (44)

Total .. 138 (120)

Deaths.

Tuberculosis of pharynx	1 (1)
Carcinoma of œsophagus	1

(5) Of the 1,000 cases, 138 were unfit for general service, of which it was necessary to discharge fifty, to place on light duty twenty-one, and on home service sixty-seven. Of these numbers, respectively, forty-four, eighteen and fifty-eight—altogether 120 out of 138—had suffered from the disability prior to enlistment. These figures further demonstrate the importance of examining recruits and of weeding out especially those suffering from certain affections of the ear. If treatment is found to be necessary, the man should be sent to his own doctor (private or panel) or to a civil hospital to have this carried out, and should be required to report at the end of a certain period, when his acceptance for the Army would be considered. Such an arrangement would effect considerable economy in the working of T.F. General Hospitals.

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F.* (*January to August,* 1916).]

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PART III (*continued from p.* 492).

(2) *Treatment of Entamœba coli Infections.*

During the course of the treatment of *E. histolytica* infections by means of emetin a good deal of information regarding the action of this drug on *E. coli* has been obtained. Similarly during attempts to get rid of flagellate infections by means of other drugs the action of these on coincident *E. coli* infections has been observed.

Emetin.—The general difference in the action of this drug in *E. coli* and *E. histolytica* infections has been discussed, and it has been suggested that *E. coli* is probably generally distributed through the large intestine and not so easily acted upon, while *E. histolytica* is more intimately associated with the ulcers and so comes more directly under the action of emetin.

In the series of cases treated by injections of emetin, one grain a day for twelve days, it will be seen that in only one instance (Osgood) did an *E. coli* infection, which was present before the end of the emetin course, fail to appear after the course was completed. It is thus evident that such a line of treatment cannot entirely get rid of an *E. coli* infection. If one looks at the charts of treatment of the individual cases it will be seen that in a few

the *E. coli* infection disappears temporarily, apparently as a result of the treatment, but that in others there is no such action whatever. It seems that this line of treatment may influence the infection to some extent but only very slightly compared with the action on *E. histolytica*.

The administration of a grain of emetin a day by the mouth was no better as regards a permanent result, though the temporary disappearance of the infection was more marked than when the emetin was given by injection.

When we consider the combined injection and oral treatment of 1½ grains of emetin a day, we find there is a much more decided action in the *E. coli* infections and indeed on all other coincident protozoal infections. In nearly every case this line of treatment has abolished all the intestinal protozoa including the *E. coli*. In four cases (English, Liddle, Graham and Smith) there was no return of *E. coli* infection during the period of control. It is evident that just as emetin by the mouth (½ grain) combined with injections (one grain) gives better results with *E. histolytica* so it does with *E. coli* infection, but the outstanding feature of the treatment is the specific nature of the action of emetin on *E. histolytica* and its comparative inaction on *E. coli* as regards permanency of cure.

Other Drugs.—Various attempts were made to get rid of flagellate infections, and as these were often associated with *E. coli* it was possible to watch the action of any line of treatment on the amœbæ also. Several cases were treated with turpentine (ten minims three times a day) in the form of mist. terebinth. There was no action on *E. coli*. Similarly *E. coli* proved refractory to bismuth salicylate twenty grains three times a day alone, and in combination with beta-naphthol fifteen grains three times a day. The latter drug alone likewise had no effect on the *E. coli* infections. A course of saline purging will do much to get rid of an *E. coli* infection and a subsequent examination of the stool may give negative results for some days. The absence however is only apparent, for the infection invariably reappears later on. Similarly attacks of diarrhœa or dysentery with much purging will mechanically wash away the majority of the amœbæ, so that an infection may apparently disappear. This is shown very clearly by the number of such cases which we found to be negative at first and which became positive as the stools began to approach normal. On the other hand, certain diarrhœic conditions favour the multiplication of *E. coli* as they do other intestinal protozoa, sometimes with

the result that a large infection may persist throughout such an attack. In one such case already mentioned, the diagnosis was in doubt for some days, for numerous amœbæ were passed constantly in a diarrhœic stool and it was only after the lapse of about ten days that the stools returned to normal and cysts of *E. coli* became numerous.

(3) *Treatment of Lamblia Infections.*

We have made numerous attempts to rid cases of their lamblia infections, but though many of the drugs tried will abolish an infection as judged by stool examination the infection almost invariably reappears.

Emetin.—This drug given in the form of injections of one grain a day for twelve days will sometimes cause a lamblia infection to disappear for a time, but given by the mouth emetin will nearly always produce a temporary clearing up of the infection. Cases Gildel, Amers and Stone, whose charts of infection are given at the end of this paper, illustrate this general rule very well. In practically all these cases the infection returns later. In one case (White) however, the infection disappeared and there was no return during a control of forty days. This case however was given a course of beta-naphthol fifteen grains with bismuth salicylate twenty grains three times a day for twelve days after the course of emetin was finished.

Beta-naphthol in a dose of fifteen grains three times a day was tried in several cases without any good result. Case Gildel was one of these. The drug did not even cause the parasites to disappear.

B. naphthol and Bismuth Salicylate.—These two drugs in the form of a powder in the proportions just mentioned above have been given to a number of cases of lamblia infection. In all these the infection has disappeared after a varying number of days, sometimes after two days' treatment, at other times after seven or eight days. So constant has been the disappearance of lamblia cysts from the stools of cases that it is difficult to believe that the drug has no action on the infection and that the vanishing of the cysts is the result of the natural course of the infection. Unfortunately however the cure is only a temporary one as the infection almost invariably reappears after a week or two of control. Only in the single case mentioned above under the emetin treatment did it appear that a cure has been effected, but whether this was the result of the emetin or the subsequent treatment cannot be stated.

Bismuth Salicylate.—This drug alone in a dose of twenty grains

three times a day was used on several cases. It was found that the action was just as certain as when the beta-naphthol was used with it. Apparently the action of the former mixture was due to the bismuth salicylate rather than to the beta-naphthol. Bismuth salicylate will usually cause a lamblia infection to disappear and thereafter the diarrhœa with associated mucus will stop also. One must not forget however that the natural course of a lamblia infection is an intermittent one and that the symptoms described above are intermittent also and will subside without any treatment whatever. It is this fact which makes a judgment on the action of a drug so difficult.

Case Baker is very interesting in this respect. He was a carrier of *E. histolytica* who was treated by the combined oral and injection administration of emetin. Three days after the course of emetin was completed a lamblia infection, not hitherto evident, made its appearance. The case was controlled for a month and as the *E. histolytica* infection did not reappear the man was discharged though lamblia cysts were still present in the stool. Five weeks later he was readmitted to hospital for colitis. The stool was examined on several occasions but there were present no lamblia cysts. Whether this was a case of spontaneous cure or whether the case was passing through one of the periods when the lamblia infection (as judged by the cysts in the stool) was in abeyance cannot be stated. The case serves to illustrate the difficulties associated with the control of cases of this kind where the infections only reveal themselves intermittently in the stool.

It appears therefore that no very satisfactory treatment for lamblia infection exists. For general purposes the treatment by bismuth salicylate seems to be the best and this drug can be given for long periods without any harmful effects. It has the advantage of clearing up the symptoms associated with lamblia infection even if it does not permanently get rid of the parasite.

It might be thought that a flagellate living in the small intestine could be attacked much more readily than one in the large intestine. As a matter of fact drugs seem to act more readily on the lamblia infection, but as explained above the relapse almost always occurs. An examination of animals infected with lamblia by sectioning the gut, has shown that the flagellates live not only on the surface of the intestine but that many of them make their way into the glands, where they can be seen in rows on the glandular epithelium. It is possible that they may spread into the bile ducts, but we have no information on this subject. The

important point in treatment and the one which makes it so difficult is that intestinal disinfectants act directly on the flagellates in the gut lumen but not on those within the glands. These escape destruction and eventually when treatment is stopped re-establish the gut infection. This hypothesis affords an explanation of the action of drugs like emetin and bismuth salicylate, which cause a temporary disappearance of infection as judged by stool examinations.

(4) *Treatment of Tetramitus Infection.*

The action of emetin on this flagellate has been observed in several cases of *E. histolytica* infection. While it can be stated that emetin in the form of injections of one grain a day for twelve days has no action on the flagellate, emetin administered orally has a decided action. In the case of Gildel who passed tetramitus regularly for three months, the administration of ½ grain of emetin by the mouth for twelve days caused it to disappear. It returned, however, some days after the course was completed. In practically all the cases of *E. histolytica* infection when tetramitus was present also, the latter disappeared during the course of treatment by the combined method of injection and oral administration (1½ grains a day). In only one case did it fail to reappear during the subsequent control of the case.

Beta-naphthol.—This drug was used in the case of Gildel mentioned above; fifteen grains were given three times a day for twelve days without any change in the tetramitus infection.

Turpentine.—Turpentine in the form of mist. terebinth. with a dose of ten minims of turpentine three times a day was tried. In one case, Peacock, the infection disappeared during the treatment, but it reappeared eight days after the course. In another case, Fulford, it had a similar effect, while in another, Buckley, the flagellates did not even disappear from the stool. It seems doubtful if turpentine given in this way can have any permanent effect on a tetramitus infection.

Bismuth Salicylate.—In a dose of twenty grains three times a day bismuth salicylate was tried on several cases. In some of these during the course of treatment the tetramitus disappeared while in others there was no such disappearance. Owing to the irregular course of these infections it is difficult to pronounce any definite opinion on the action of this drug, for we have not controlled these cases sufficiently. A subsequent control of less than one month after treatment is insufficient to enable any result to be claimed as a permanent cure.

It is evident that though certain drugs will cause a tetramitus infection to disappear, there is nearly always a subsequent relapse. No satisfactory treatment for the infection is known.

(5) *Treatment of Trichomonas Infections.*

Naturally enough, with an infection which runs such an intermittent course, it is exceedingly difficult to judge the action of any line of treatment. From the tables of the cases treated by emetin where trichomonas infections co-existed it does not appear that this drug has any action on the flagellate.

Turpentine.—This drug in a dose of ten minims three times a day (in mist. terebinth.) has been tried in several cases of trichomonas infection. One of these cases (Ruane) had an infection in a soft unformed stool. The mixture was taken for twelve days and trichomonas was last seen the day before the end of the course. The stools were examined on eight occasions during the next month, but no flagellates were found. It must be stated, however, that during the period of control the stools were formed so that the flagellate may still have been present in the gut though not in the stool. In another case (Fulford) where there was a mixed infection of trichomonas, tetramitus, lamblia and *E. coli*, the first named flagellate disappeared during the course of mist. terebinth. but reappeared afterwards. It is thus manifestly impossible to tell if the turpentine was or was not responsible for the disappearance of trichomonas in the first case or for its temporary disappearance in the second.

Bismuth Salicylate.—This drug has been given in doses of twenty grains three times a day to cases of trichomonas infection, but the results we have obtained are as indefinite as with the other treatment employed.

(6) *Treatment of Coccidial Infections.*

As we have stated above, only one case of this infection (Isospora) was encountered by us in Egypt. This was in a carrier case of *E. histolytica*, and as we have already explained, one grain of emetin subcutaneously administered for twelve days failed to effect a cure of either the *E. histolytica* or coccidial infection, whereas a second course of emetin, one grain injection and ½ grain by the mouth, caused both infections to disappear and no relapse occurred. If we may judge from this single case, it may be assumed that emetin had some action in getting rid of the coccidial infection.

(7) *Treatment of I-cyst Infections.*

Several of the cases of *E. histolytica* infection have had I-cysts present also, so that we have been able to note the action of emetin on these. Both emetin injections (one grain a day) and emetin by the mouth appear to cause the I-cysts to disappear from the stool. We have not followed any single untreated I-cyst infection for long, so we cannot be quite sure that the disappearance was not accidental, but under the emetin treatment the I-cysts vanish after the second or third day of the course and they do not recur during the subsequent control of the case. It seems reasonable to assume that the emetin was the cause of their vanishing. As however we know nothing of the behaviour of I-cysts in the intestine and as they do not appear to be pathogenic in any way unless their occasional presence in large numbers in the fæces of sick people is a sufficient argument in favour of pathogenicity—the question of the treatment is not one of practical importance.

(8) *Treatment of Blastocystis Infections.*

We have no definite information to offer as regards the action of drugs on blastocystis. Emetin by the mouth combined with injections has the power of clearing away all protozoal infections of the gut and with these vanish, as a rule, the blastocystis infection as well.

Summary of Matter Discussed in Part III.

(1) The cases treated by emetin hydrochloride fall into three groups, all of which were treated for twelve days: (1) those treated with a daily one-grain injection of emetin, (2) those treated with a daily one-grain dose of emetin by the mouth, and (3) those treated with a daily one-grain injection of emetin together with half a grain dose by the mouth. The result is based on a control of each case for at least one month after treatment.

Under group 1 were treated fifty-two carriers. Of these 37 were cured, 10 relapsed, and 5 showed no reaction to treatment. Six acute cases all relapsed after treatment.

Under group 2 were treated nine cases. Of these 6 were cured, 2 relapsed, and 1 showed no reaction to treatment. Of three acute cases, two relapsed and one did not react to treatment. One very chronic case was cured by emetin 5½ grains by the mouth during seven days.

Under group 3 were treated thirty carrier cases. Of these all were cured. Of seven acute cases two were cured and five relapsed.

(2) Methyl emetin sulphate in a dose of two grains a day for twelve days (one grain injection each morning and one grain by the mouth each night) failed to cure two acute cases but was successful in curing one carrier case. Methyl emetin sulphate does not produce vomiting so easily as emetin hydrochloride.

(3) One case which did not react to emetin hydrochloride was treated without result with thymol and pulvum ipecacuanha.

(4) In the treatment of carriers the object is to kill the amœbæ and not the cysts which are harmless to the individual who passes them.

(5) A comparison of the three lines of treatment adopted shows that the best results are obtained by the combined injection and oral administration of emetin (a total of 1½ grains of emetin daily.)

(6) It is evident that the healthy or comparatively healthy carrier is much more easily cured of his infection than the acute case with actual dysentery, especially when there is a history of repeated attacks of dysentery. It is possible that in some long standing cases the condition of the ulcers in the intestine prevents the emetin reaching the amœbæ.

(7) It appears at first sight that in certain cases emetin-resistant strains of amœbæ exist. The resistance is however only apparent, and is probably due to the emetin not having reached the amœbæ.

(8) There is no evidence to prove that injections of emetin tend to make the amœbæ encyst or to increase the number of carriers.

(9) The action of emetin on *E. histolytica* is not influenced by any coincident protozoal infections.

(10) In the case of carriers it is doubtful if rest in bed and diet assist the emetin in its action on *E. histolytica*. Rest in bed however is useful in preventing ill-effects of emetin on the patient. Acute cases should be kept in bed on dysentery diet.

(11) It is doubtful if salines regularly administered influence the emetin treatment in any way.

(12) Emetin may produce irregular action of the heart when given in large doses. Administered by the mouth emetin readily causes vomiting, which however does not hinder the action of the drug on the amœbæ.

(13) All the treated cases which have relapsed have done so in under twenty days after the completion of the course, with the exception of three which relapsed in under thirty days.

(14) A previous history of a single attack of dysentery (which may or may not have been bacillary but most probably the latter) has very little effect on the treatment of carrier cases. Cases which

have suffered from repeated attacks of dysentery are difficult to cure. A history of repealed attacks would indicate an amœbic rather than a bacillary infection.

(15) Previous emetin treatment does not affect the subsequent treatment unless it means that there has been a long history of repeated attacks of dysentery.

(16) Emetin injected under the skin may be some time in reaching the amœbæ, so that its action may be delayed.

(17) As acute cases of amœbic dysentery so frequently relapse after emetin treatment it is suggested that after the course of emetin ($1\frac{1}{2}$ grains subcutaneously and orally administered) the case might possibly be given a long course of emetin in small doses by the mouth as is done in the case of malaria and quinine or trypanosomiasis.

(18) Emetin by the mouth will frequently get rid of *E. coli* infections but relapse almost invariably occurs.

(19) Emetin by the mouth will also temporarily get rid of flagellate infections (lamblia, tetramitus and trichomonas). Bismuth salicylate will also abolish these infections, but relapse occurs after short courses. Longer courses might give good results.

(20) Both emetin injections and emetin by the mouth appear to cure I-cyst infections. Emetin by the mouth appears to have some action in abolishing a blastocystis infection. One case of coccidium (isopora) infection appeared to be cured by emetin $1\frac{1}{2}$ grains a day administered orally and by injection.

(*To be continued.*)

A CLINICAL AGGLUTINOMETER.

An Apparatus for Use at the Bedside or in the Laboratory for making Rapid Estimations of the Agglutinin Titre of the Blood.

By Captain R. P. GARROW.
Royal Army Medical Corps.

[*A Report to the Medical Research Committee.*]

In the *Archives of Internal Medicine*, December 15, 1910, C. C. Bass and J. A. Watkins describe "A quick macroscopic typhoid agglutination test." In carrying out this quick test a drop of 1 in 5 dilution of blood is placed on an ordinary plain microscopic slide along with a drop of a specially dense (about 10,000 per cubic centimetre) emulsion of *Bacillus typhosus*. The two drops are mixed together on the surface of the slide, and made to move to and fro by gently rocking the latter for two minutes. A positive result is indicated if the emulsion is broken up into small white masses, or clumps visible with the naked eye.

The technique about to be described is simply an elaboration of Bass and Watkins's method with the object of rendering it not merely a qualitative test for agglutinins in the blood, but an accurate quantitative estimation of the agglutinin titre of the blood. This object is attained by means of an apparatus which I have devised and called a "clinical agglutinometer."

The clinical agglutinometer consists of the following parts:—

(1) *A Diluting Slab.*—A painter's palette made of glazed white porcelain having three rows of seven small cups, and a trough in which the saline solution is contained. (See fig. 1.)

(2) *A Diluting Pipette.*—The pipette supplied with Dreyer's outfit answers very well. For the purpose of this technique, the diluting pipette nozzle need not conform to any "standard" size, as only one pipette is used throughout the diluting process for any number of bloods. Therefore no "pipette error" is introduced into the diluting process. Dreyer's pipettes appear to have a nozzle equal to Morse gauge 41.

(3) *The Agglutinometer Slide.*—This consists of a piece of ordinary clear glass twenty-five centimetres long and four centimetres broad, with smooth edges. It is divided by double grooves cut cross-wise on one surface at regular intervals of one centimetre

The grooves are one millimetre deep by one millimetre broad and one millimetre apart. They divide the surface of the slide into spaces seven millimetres broad and four centimetres long. These are the spaces on which the agglutination tests are carried out. There are twenty-one "test spaces" on the slide.

(4) Capillary pipettes accurately gauged *à la* Mr. R. Donald (see *Lancet*, December 4, 1915, and September 2, 1916), and fitted with rubber teats.

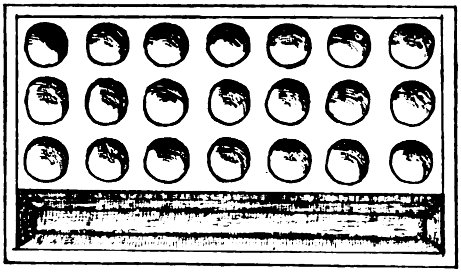


FIG. 1.

The object of these pipettes is to distribute at the opposite ends of the "test spaces" on the agglutinometer slide equal drops of the various dilutions of the blood-serum and the bacterial emulsions, of such volume that, when the agglutinometer slide is made to revolve in the mechanical mixer each drop of diluted blood-serum will run into and mix freely with its corresponding drop of bacterial emulsion, but will not run off the slide at its edge, nor across the grooves into adjacent dilutions.

The size of capillary nozzle which fulfils these requirements is Morse gauge 70.

(5) *Set of Emulsion Bottles in Stand.*—The bacterial emulsions I have used in the agglutinometer are: *B. typhosus* (Eberth), *B. paratyphosus* A (Brion-Kayser), *B. paratyphosus* B (Schottmüller, *B. dysenteriæ* (Shiga), *B. dysenteriæ* (Flexner), *B. dysenteriæ* (His), *B. enteritidis* (Gaertner), *B. fæcalis alkaligenes*, *B. coli communis*, *Vibrio choleræ* (Koch), *Micrococcus melitensis* (Bruce), *M. paramelitensis*. The emulsions are made from twenty-four-hour surface agar cultures. The growth is scraped off the surface of the medium in platinum loopfuls, and emulsified in 0·1 per cent formalin in normal saline. The emulsions used for this method should be dense ones—about 10,000 million per cubic centimetre.

The density of all the emulsions should be uniform as far as the eye can judge.

(6) *The Mechanical Mixer.*—This consists of a mechanical contrivance by means of which the agglutinometer slide is made to revolve on its long axis slowly (about ten revolutions per minute) in an atmosphere saturated with aqueous vapour. The moist chamber is a cylinder of celluloid placed horizontally, the upper half being jointed to form a lid, the lower half lined with filter paper soaked with water. The revolving movement is obtained by means of a simple clockwork attached at one end of the cylinder. The clockwork is self-stopping every fifty revolutions—i.e., every five minutes. (See fig. 2.)

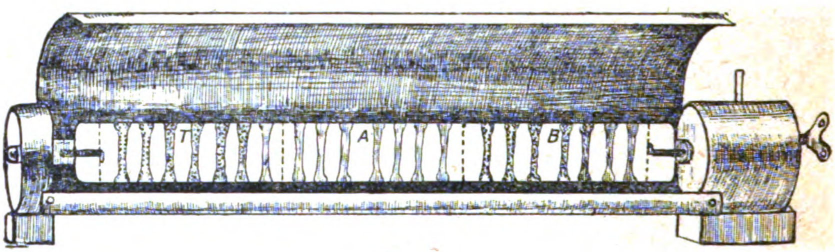


FIG. 2.

(7) *A Pocket Centrifuge.*—A small apparatus, not larger than a matchbox and weighing less than two ounces, for centrifuging the blood in Wright's capsules.

(8) Pocket Lens. Spirit lamp. Bottle of normal saline. Swabs of cotton wool. Wright's capsules. Agglutinating sera.

DESCRIPTION OF TECHNIQUE IN THE USE OF THE CLINICAL AGGLUTINOMETER.

(1) *The Diluting Process.*—(*a*) The blood for examination is taken from the lobe of the ear in the usual manner into a Wright's capsule, and centrifuged. (*b*) By means of a dropping pipette (which during the whole process should be held vertically to ensure equality in size of the drops) place four drops of saline into a cup No. 1 of the diluting slab and two drops into each of the other cups in the row. (*c*) To cup No 1 add one drop of the serum to be tested and three times. This forms a 1 in 5 dilution of the patient's mix thoroughly by drawing into and expressing from the pipette serum. (*d*) Transfer two drops from the cup No. 1 to cup No. 2 and again mix thoroughly. This forms a 1 in 10 dilution.

(*e*) Again transfer two drops from cup No. 2 to cup No. 3 and mix thoroughly. This yields a 1 in 20 dilution, and so on to cup No. 7 (1 in 320 dilution).

(2) *The Mixing Process.*—The process of mixing the blood-serum and bacterial emulsions is carried out on the test spaces on the surface of the agglutinometer slide. Using a Donald's pipette Morse gauge 70, which is held vertically, begin with the highest dilution (1 in 320) and deposit drops of the various dilutions of blood-serum in triplicate on the slide which is lying flat on the bench. Opposite each drop of serum place a drop of bacterial emulsion, as shown in the figure :—

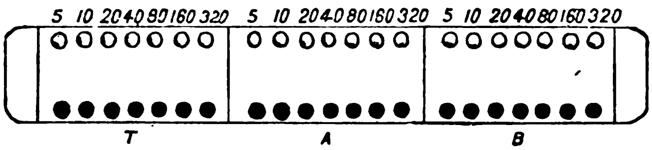


FIG. 3.

The slide so loaded is placed carefully in the moist chamber of the mechanical mixer, where it is received and held fast by a clip at each end. The clockwork is started by means of the lever, and the slide allowed to revolve slowly till the clock stops after completing fifty revolutions of the slide.

When the slide begins to revolve the various drops of diluted blood serum run into and mix freely with their corresponding equal drops of bacterial emulsion, producing mixtures having serum titres $\frac{1}{10}$, $\frac{1}{20}$, $\frac{1}{40}$, $\frac{1}{80}$, $\frac{1}{160}$, $\frac{1}{320}$, $\frac{1}{640}$. (See fig. 4.)

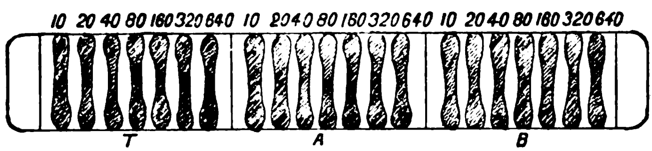


FIG. 4.

At each complete revolution of the slide the bulk of these mixtures runs to and fro across the slide.

When the clockwork stops, the agglutinometer slide is removed and examined by the naked eye (aided, if necessary, by a pocket lens) *in a good light against a black background.* Agglutination converts the mixtures from homogeneous milky emulsions into a

condition in which the agglutinated masses of bacilli float about like minute white flakes in a clear fluid. In a strongly agglutinating blood this takes place in the lower dilutions almost instantaneously after the agglutinometer slide begins to revolve. The change is very striking, and can be easily seen with the naked eye. In the higher dilutions the change may take three or four minutes, and be observable only with the aid of a pocket lens. If no change is visible with the pocket lens in the 1 in 10 dilution at the end of five minutes' time limit, no agglutinin of any diagnostic significance is present in the blood.

The following diagram represents the appearance of the agglutinometer slide in the case of a patient whose blood agglutinates T up to 1 in 320 and B up to 1 in 160, the A emulsion being negative.

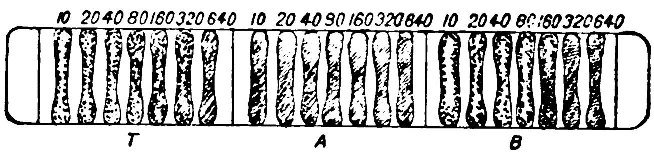


FIG. 5.

Note.—It is absolutely essential that the examination of the slide be carried out in a good light against a black background some distance away (say three or four feet), otherwise it is difficult or impossible to read the result.

In examining the bloods of patients suffering from typhoid and paratyphoid infection, it will frequently happen that all the dilutions up to 1 in 640 show agglutination. In such a case a further series of higher dilutions in the same geometrical progression is made, thus: (*a*) Into each of the cups in the second row on the diluting slab drop two drops of normal saline. (*b*) Transfer two drops from the 1 in 320 dilution to cup No. 1 of the second row, and mix thoroughly; this makes 1 in 640 dilution. (*c*) Transfer two drops of 1 in 640 dilution into cup No. 2 of the second row, and mix thoroughly—and so on to as high a dilution as it is considered necessary to reach the agglutinin titre of the blood. Now clean the agglutinometer slide with a cotton-wool swab wet with 5 per cent. carbolic, dry it and flame it. Distribute the higher series of dilutions in drops on the slide in precisely the same way as for the lower series of dilutions; place opposite each dilution a drop of emulsion; put the slide in the mechanical mixer, as before, and set the clockwork going.

The agglutinin titre of the blood is *the highest dilution in which definite flakes of agglutinated bacilli can be seen with the aid of a pocket lens*. It is, of course, essential that the dilution beyond this (the ultimate dilution) be *absolutely negative*. This indicates the penultimate dilution as the limit of the agglutinin titre of the blood, and acts as a control for each test.

Theory of Action of the Agglutinometer.

For the purpose of explaining the action of the agglutinometer, the phenomenon of agglutination may be considered to consist of two processes:—

(1) The union of agglutinin with the agglutinable substance (whether this is in the nature of a true chemical union, or is merely "absorption," is here immaterial).

(2) The aggregation of the bacilli into clumps. Both these processes are greatly accelerated by the movement to and fro to which the mixtures of serum and emulsions are subjected in the mechanical mixer. Different portions of agglutinin and agglutinable substance are constantly being brought into contact with one another, and their union facilitated. The same constant movement of a staining solution over a section of tissue or a blood film hastens the staining process and renders it more complete. For the same reason photographers use a mechanical rocker which causes the developing solution to move constantly to and fro over the photographic plate. The physical change—the aggregation of the bacilli into clumps—is also greatly accelerated *by rolling the bacilli on one another*. In the lower dilutions in which agglutinin is concentrated, agglutination appears instantaneously throughout the emulsions, but in the higher dilutions in which agglutinin has been reduced to a mere trace the clumps will be seen to form slowly along two lines which correspond to the junction of the quickly moving central stream and slowly moving peripheral stream on either side—that is to say, the position in which the rolling action on the bacilli is most marked. They tend to pass outwards into the peripheral stream, and finally settle along the edge of the fluid.

The Uses and Advantages of the Clinical Agglutinometer.

Simplicity.—The technique is simple and easy. Little is left to the manipulative dexterity of the operator, and thus satisfactory results should be obtained by men with little experience of the method.

Speed.—The method is extremely rapid. After a little practice, specimens of blood can be examined, and the results recorded at the rate of ten per hour—an all-important consideration in war-time.

Accuracy.—The titre found by the agglutinometer in five minutes is the same on an average to within one dilution as that obtained by the elaborate method in tubes in two to twenty-four hours. The end point is as sharp as that in tubes, and easily read after a little practice. The method is therefore capable of detecting with all-sufficient accuracy those fluctuations in titre which take place during the course of enterica in inoculated individuals. The special sphere of usefulness of the clinical agglutinometer is in the making repeated examinations in those cases of clinical enterica after triple inoculation, in which attempts at isolation of the bacillus from the blood, urine, and fæces have failed. Evidence is accumulating that in these cases this method of examination gives valuable help in diagnosis at a small cost in time, trouble, and material.

(*Note.*—The diagrams illustrating this article were kindly drawn for me by Captain Philip H. Bahr, R.A.M.C.)

The clinical agglutinometer may be obtained through Dr. Thos. G. Nicholson, resident medical officer, the London Fever Hospital, Liverpool Road, Islington, London, N.

Clinical and other Notes.

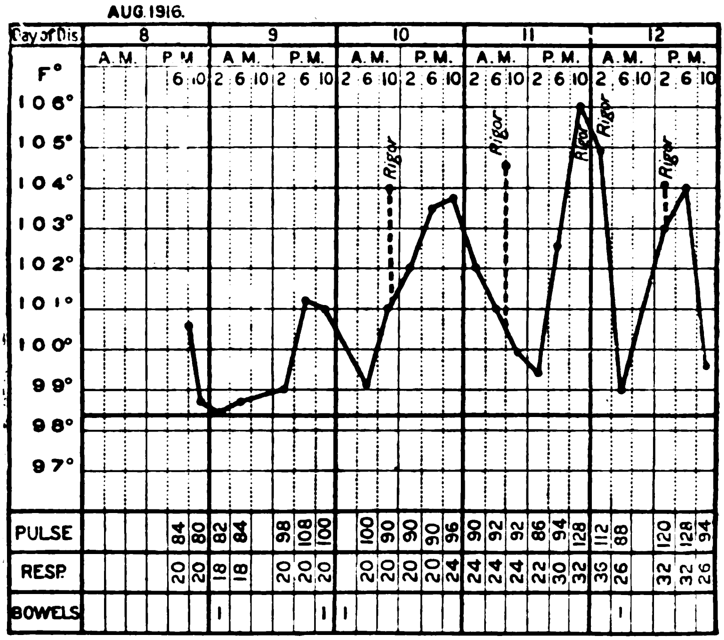
A CASE OF SEPTICÆMIC CEREBROSPINAL MENINGITIS DUE TO AN ORGANISM RESEMBLING IN MANY RESPECTS THE WHOOPING-COUGH BACILLUS OF BORDET AND GENGOU.

By Captain C. H. TREADGOLD, M.D.
Royal Army Medical Corps.

Pte. Ames, aged 19, was admitted August 8, 1916, complaining of headache and stiff-neck.

Previous History.—Had been feeling out of sorts with a slight cold for about three weeks. Headache on and off during the last fortnight. Two days before admission had a shivering fit accompanied by feverishness, while the headache became worse.

Present Condition.—On examination, the temperature was 101·8° F., pulse 84, and respirations 20 per minute. There was marked stiffness of the neck, and pain on passive movement of the head forwards. Kernig's sign was well marked. The mind was clear. August 8, 1916: Feels better after a comfortable night. Forty-eight cubic centimetres of clear fluid were withdrawn by lumbar puncture. August 10, 1916: Slept well, but was restless and thirsty at intervals. About 10 a.m. had a rigor, during which the temperature (rectum) reached 104° F. Another slight rigor at 3 p.m. August 11, 1916: Restless during the earlier part of the night; then slept well until 6.30 a.m. when he had another rigor. (Temperature 104·6° F., pulse 124, respirations 26.) Mind quite clear, but inclined to be drowsy. Slight cough with blood-stained expectoration; 9.30 a.m. twenty-two cubic centimetres of perfectly clear fluid was withdrawn at very low pressure. Two more rigors during the day, the temperature rising to 106° F. August 12, 1916: Quite comfortable this morning except for some headache. Temperature 99° F., pulse 88, and respirations 26 per minute. No abnormal physical signs detected in chest, although complaint was made of some discomfort over the left lower ribs. August 13, 1916: Passed a very restless night and complained of feeling chilly at intervals. August 14, 1916: Restless during the early part of night. Rigor 6.45 a.m., when he became very cyanosed and showed signs of collapse. Cough rather troublesome with blood in sputum. Impaired note at bases of both lungs. August 15, 1916: Had a fairly good night, but rigor at 6 a.m. accompanied by the usual symptoms. Had no rigor during the day, but vomited twice. August 16, 1916: Has been very ill all day. Has vomited three times. Complains of tenderness all over abdomen. Colour is bad, with patchy cyanosis of


AUG. 1916.
Day of Dis.
8 9 10 11 12
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Rigor
PULSE
RESP.
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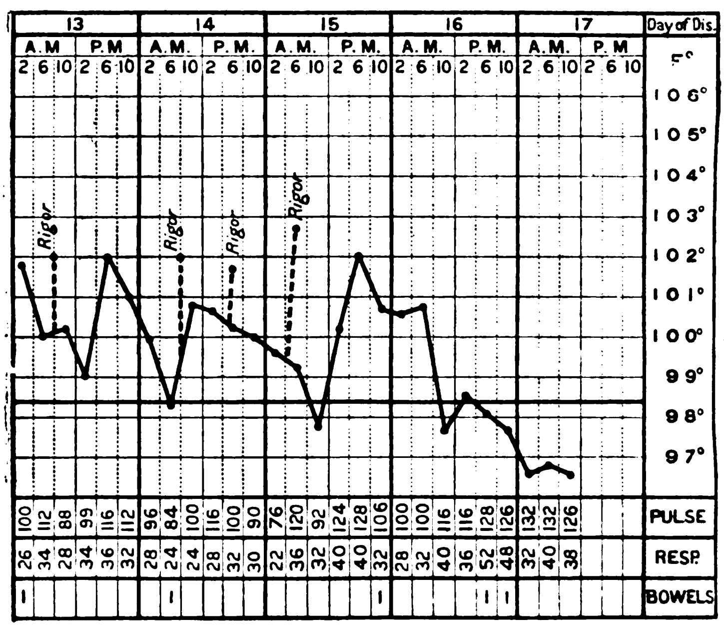
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Rigor
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BOWELS

skin. No rigors, but has perspired freely on and off all day. On the whole the condition is worse and the patient is getting jaundiced. August 17, 1916: Has been very bad all night—restless and delirious, vomiting about six times. Temperature 96·8° F., pulse 132 and respirations 40 per minute. The condition is getting rapidly worse. The patient coughs and complains of abdominal tenderness. The spleen and liver dulness appear to be increased. The bases of both lungs are dull. The pulse is feeble and failing. He has cold sweats and is getting progressively weaker. Death occurred at 3.10 p.m.

Autopsy Notes.

External Appearance.—Skin yellow, post-mortem hypostasis marked.

Nervous System.—Brain: Yellow staining of dura mater. Hyperæmia of pia-arachnoid with turbid fluid in subarachnoid space. Slight excess of blood-stained fluid in ventricles. Spinal cord: Membranes injected on incising the dura yellow pus welled up.

Respiratory System.—Breaking down, semi-purulent patches of broncho-pneumonia at both bases.

Vascular System.—Early endocarditis of mitral, pulmonary and aortic valves.

Digestive System.—Fibrino-purulent peritonitis for which no gross pathological cause was found. The liver weighed 81½ ounces; it was enlarged, congested and fatty.

Excretory System.—The right kidney weighed 6½ ounces, the left kidney 5½ ounces. The ratio of cortex to medulla was unchanged, but fatty degeneration was marked.

Ductless Glands.—The spleen weighed 6 ounces, it contained an abscess about the size of a walnut, while its external surface was covered with rather adherent, semi-purulent lymph.

Laboratory Investigations.

The fluid withdrawn by lumbar puncture on the day following the patient's admission was examined immediately. A serum-legumin-agar plate was inoculated with several large loopfulls and incubated at 37° C. No very obvious deposit was noticed after centrifugalization of the remainder, but microscopical examination of the "last drop" showed a few polymorphs, lymphocytes and endothelial cells, together with extra-cellular clumps of minute, slender, Gram-negative bacilli with rounded ends; they were occasionally present inside the cells, but never in large numbers. A morphologically similar organism grew on the serum agar; its characters and affinities will be presently discussed. August 11, 1916: The sputum was examined. Stained preparations showed various organisms, amongst which were occasional groups of minute, Gram-negative bacilli. The blood was examined on three occasions. Speaking

generally, there was leucopenia with a relative increase of the polymorphonuclear leucocytes, as the accompanying table shows:—

TABLE I.

	August 11, 1916	August 13, 1916	August 15, 1916
White cells per cubic millimetre	5,600	12,800	2,600
Differential Count (500 *counted*).			
Polymorphs	81·0 per cent	83·2 per cent	86·8 per cent
Lymphocytes (large and small)	8·0 ,,	5·2 ,,	4·6 ,,
Hyalines and transitionals	11·0 ,,	11·2 ,,	8·2 ,,
Türck cells	0 ,,	0·4 ,,	0·4 ,,

In stained preparations the polymorphs were found to vary considerably in size; amphophilic granulation and vacuolation both of nucleus and cytoplasm were commonly met with, while granular polymorphs were occasionally seen. Many of the hyalines looked extremely large, and showed numerous vacuoles; some of these latter contained small inclusions which stained pink with Giemsa, and which might have been the remains of phagocyted bacilli; these inclusions were not noticed at the last examination. The urine was examined just before death. Specific gravity 1021, acid, no albumin, sugar, pus or blood; however, Gmelin's test for bile was positive. Microscopical examination of a centrifuged specimen showed a few granular and fatty epithelial casts, also numerous epithelial cells and free fat globules; the organized elements were deeply bile stained.

Post-mortem Investigations.—Stained smears from the splenic and peritoneal pus and from the purulent foci in the lungs all showed enormous numbers of small, Gram-negative bacilli; however, no organisms were noticed in the pus from the spinal cord.

CHARACTERS OF THE BACILLUS ISOLATED FROM THE CEREBROSPINAL FLUID.

(*a*) *Cultural Characteristics.*—A serum-legumin-agar plate, inoculated with several large loopfuls of the fluid, showed one small clear colony after forty-eight hours at 37° C. This was composed of minute, Gram-negative bacilli, and a subculture on blood-streaked serum-agar grew fairly readily. After forty-eight hours, subcultures were made into serum-agar and blood-streaked agar, good growth resulting in both tubes. After twenty-four hours, the colonies were very clear and so small as to be almost invisible; after forty-eight hours they were considerably larger and less clear; they subsequently became grey and confluent, and after repeated subculture a confluent growth was obtainable from the start. Stab cultures into serum agar showed the organism to be a strict aerobe. No growth was obtained on the ordinary media at first, but later attempts were more successful, and eventually the organism grew freely on ordinary agar, but never very freely in broth. Loeffler's serum and litmus milk were unfavourable media, both giving negative results to start with.

Many unsuccessful attempts were made with gelatine; finally a slight growth was obtained during the first forty-eight hours, but the organism rapidly died out, although controls on serum-agar grew fairly well at 23° C. Growth on potato was grey and transparent.

The Sugars.—The following carbohydrate media showed no change after ten days, when the organism was recovered in pure culture—glucose, lactose, saccharose, mannite and dulcite; the growth occurring in these media was scanty.

Vitality.—Subcultures were successfully made from fourteen days old cultures on the optimum media (serum agar), but subcultures from twenty-one days old slopes were uniformly unsuccessful. Vitality on ordinary agar was less than this.

(*b*) *Morphology and Staining Reactions.*—A small, non-motile and Gram-negative cocco-bacillus, which stained somewhat more readily than *Bacillus influenzæ* with aniline dyes—both basic and acid; on the whole, thionin blue and safranin gave the best results. Polar staining was sometimes very well shown, ten per cent aqueous safranin being especially good for this purpose; at other times, however, it could not be demonstrated and this was especially noticeable in young cultures on serum-agar, uniformly staining rods being almost exclusively present under such conditions; however, bacilli showing polar staining and coccoid forms soon developed, in fact coccoid forms usually predominated from the first on unfavourable media. True involution forms appeared after a few days; these consisted of delicate filaments up to fifteen microns in length, some being beaded, while others stained uniformly; the uniformly staining ones were usually the first to appear. Large coccoid elements, sausage-shaped forms and filaments with swollen extremities developed after a few days in broth. In all cases the original bacillary form was quickly resumed on returning to serum agar.

(*c*) *Agglutination Tests*:—

I. Meningitis bacillus + patient's serum 1/20, 1/60, 1/120 all negative.
II. „ „ + normal serum 1/20, 1/60, negative.
III. *B. influenzæ* + normal serum 1/20 partial agglutination; 1/60 negative.
IV. „ „ + patient's serum, 1/20, 1/60, 1/120, all negative.

The above were examined microscopically after one hour's incubation at 37° C.; all controls were negative.

(*d*) *Results of Animal Experimentation.*—Lieutenant-Colonel Gordon injected an emulsion of the bacillus into the peritoneal cavity of a guinea-pig; the animal remained unaffected.

Conclusions.

The fact of a confluent growth being obtained in the absence of hæmoglobin sufficiently distinguishes this organism from the influenza bacillus. Whether or no it was identical with the whooping-cough

bacillus of Bordet and Gengou, I am unable to say. Lieutenant-Colonel Gordon, who examined the cultures, thinks it is possibly a new organism. Agglutination tests might have decided the point had the serum from a convalescent case of whooping-cough been available; although this was unfortunately omitted, the apparent rarity of the condition would seem to justify attention being called to it. I am much indebted to Colonel Carter, R.A.M.C., for allowing me to incorporate his clinical notes, and to Lieutenant-Colonel Gordon, R.A.M.C., for so kindly helping me with the bacteriology.

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MECHANO-THERAPY AT THE CROYDON WAR HOSPITAL.

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Under a new name, modern bone-setting methods have assumed a degree of importance, and been attended by an improvement in detail, the obvious outcome of the opportunities afforded by the many and varied disabilities occasioned by the War.

To illustrate this it is proposed to give a short description of the procedure followed in Divisions I and IV of the Croydon War Hospital, the patients in which are under my care. These patients are supposed to be such as are capable of being made into efficient soldiers within six months. The admissions, however, include many in regard to whom such a rule is not applicable, and where palliative measures only can be adopted.

The procedure is inclusive of, and may be usefully considered under the following: (1) Radiographic information; (2) manipulations under

anæsthesia; (3) massage, and the special work of that department; (4) special exercises and general gymnastics; and (5) splintures.

(1) Radiographic Information.

In every case where a lesion involving bones or joints exists, or where there is a suspicion that the function of the part is being interfered with by bony injury, by the presence of metallic fragments, or by other ascertainable cause, an X-ray is taken on admission.

It is, however, quite unusual, in our experience, to admit patients who have not been X-rayed in other hospitals, on one or more occasions, and it is equally exceptional to find that they are accompanied by their X-ray plates or prints. It is a pity that this should be so, as in the majority of cases the necessity for a fresh picture would have been obviated.

There are, of course, patients whom it is advisable to have X-rayed more than once, and where valuable information may be obtained by so doing. In one of our cases, a gunshot wound of the left elbow, which was described as being fixed at a right angle, three X-rays were taken, one at the beginning, one during, and one at the end of the treatment. In the first, the report stated that the joint was disorganized, the olecranon fractured, and much shrapnel dust embedded in it. The outlines of the bones entering into the joint were scarcely discernible. At the earnest request of the patient, the joint was examined, under an anæsthetic, and appreciable movement was obtained. This was maintained, and subsequently increased by massage and forced movements, aided by the persistent efforts of the patient himself. In the second, the disorganization was less marked, and the bony outlines were becoming apparent. In the third, the outlines were clearly defined, whilst the functions of the joint had been restored, for all practical purposes, and the patient discharged for full duty.

(2) Manipulations under Anæsthesia.

An examination under anæsthesia is undertaken in every suitable case where there is any undue interference with the function of a part, or in which some movable obstruction exists, and where the radiograph shows no lesion likely to be aggravated by the examination, or by the subsequent manipulations. The anæsthetic generally used is A.C.E., which is given to the point of ensuring complete muscular relaxation. The extent of the disability is determined, the limitation of movement defined; any fibrous adhesions are broken down; and any obstruction, capable of being rectified, is overcome. No undue force is ever used, and in no case has inflammation or notable swelling followed, whilst considerable improvement has, in practically every case, resulted. It may be of interest to note that out of the first 100 cases thus operated on seventy-five returned to full duty. Massage is commenced within a few hours of

the manipulations, light in character if pain be present, more firmly otherwise. The pain from the breaking down is usually quite transitory, and passes off in the course of an hour or so. Massage and radiant heat are continued for a week or ten days, when exercises by weights and pulleys are commenced. During the first week of these exercises massage is still continued, as the muscles are often inclined to be painful from their unaccustomed use.

In certain cases a previous attempt had already been made, and some disturbance caused, in consequence of which the joint had been immediately placed at rest on a splint. The disturbance may possibly have been due to a too early interference, or a too vigorous attempt at movement. Early interference is to be deprecated, where there has been destruction of tissue by gunshot or shell, followed by suppuration. Many of these cases clear up wonderfully by expectant treatment, and it is not until all danger of lighting up any latent mischief has passed, and further improvement appears to be at a standstill, that forcible manipulation is advisable.

(3) Massage, and the Special Work of that Department.

The treatment given in the massage department includes radiant heat; hot water and contrast baths; the ordinary massage manipulations and movements; besides the faradic, galvanic and sinusoidal currents, and ionization.

The treatment is given daily, in length varying according to the case, the minimum duration being half-an-hour.

Radiant heat baths are used wherever suitable, but are liable to blister recently healed scars, so where there is a fear of this or other adverse result happening, hot water or contrast baths of alternating hot and cold water are used instead.

Ordinary massage manipulations are well known, and need no elaboration, nor is it necessary to dilate upon the results achieved by their use. It may be advisable, however, to point to their indispensability when associated with one or other form of electric treatment, in maintaining nutrition, and in preventing muscular degeneration resulting from disuse, whether caused by nerve injury or through the absence of volitional impulses.

A certain amount of controversy seems to exist as to whether massage should prove a painful process or not. In the class of cases we have to deal with, massage and its attendant movements must cause discomfort, and occasionally pain, from the nature of the disabilities they have to overcome. So that, in so far as we are concerned, light effleurage alone, and the much admired gentle stroke of massage, are merely a waste of time. On the other hand, in the massage of recent fractures, sprains, synovitis, and allied conditions, anything in the nature of roughness must be avoided.

The movements, which are a very important part of the treatment, may be either passive, forced, or active, the latter being assisted, free, or resisted.

In addition to the usual remedial exercises, a great many of the Swedish gymnastic exercises are used, both free standing and on the wall bars. For instance, for those with arm injuries, many of the shoulder-blade movements and heaves are used, whilst for the leg cases deflective leg and free-standing balance movements are found very useful both for stretching shortened tendo Achilles and ham-string muscles, and also for improving the muscle sense, which is often impaired. Similarly, many exercises out of the other groups are used either to strengthen weakened muscles, or by passive extension to lengthen contracted tissues.

The hand cases are improved by gripping and pinching india-rubber balls of various sizes, of which the "fairy" ball is the most convenient, as it possesses a roughened surface. Perhaps the better and more lasting contrivance is that named by our patients the Zeppelin, which is constructed like a football, but made in the shape of an Indian club. It was designed by our Commandant Lieutenant-Colonel H. E. Deane, and made by Spencer, Heath & Co. By its use, rapid progress is made in those cases where flexion is deficient and weak. At the start many can only just finger the thick end, but day by day they increase their range of movement till the small end can be firmly held.

Besides the actual movements, it is necessary in many cases to teach the patient to relax one group of muscles, whilst he is endeavouring to use the weaker antagonists, as until his muscles are re-educated the only result of his efforts to contract the weakened muscles is to render their work still more difficult, by strongly contracting their antagonists.

It is in these cases, and more especially in those where volitional movements are wholly or partially absent, that the greatest technical skill, and the highest powers of the masseuse, both physical and mental, are demanded. Little or no progress need be expected unless the masseuse is able to gain the patient's confidence, and to convince him that he *can* get better, and that muscular power *will* return. Having thus put the patient in a frame of mind conducive to recovery, the masseuse has then, by force of will, to compel him to use muscles and to move joints which he has believed, often for months together, to be quite useless.

The patient must never be allowed to make half-hearted attempts to regain movement, but each time must be made to put his whole energy into the effort, convinced that if only he tries hard enough he will be successful. The masseuse also must be entirely engrossed, for if she allows her attention to wander at all her influence on the man will lessen, and his efforts will become relaxed.

Every little sign of recovery must be emphasized in order to encourage him to further effort, whilst no disability should be pointed out, nor pain dwelt upon, as this tends to weaken his volition.

Mental suggestion thus plays a highly important part in the treatment. Indeed, unless the masseuse is possessed of a strong mentality, it would often be better for the patient, especially if neurasthenic, to receive no treatment at all, rather than to be under treatment for months, making practically no progress, and having his conviction strengthened that he can never recover.

In general, in order to get the best results from massage and the allied exercises, it is essential that the officer in charge should give his directions personally to the masseuse, and should receive from her a weekly report on the cases. At Croydon the head masseuse is present at the manipulations under anæsthesia, and at the examination of every case, both on admission and during my rounds of the wards. Any special details or alterations in treatment are duly noted by her, and are transmitted to the masseuse in charge of the case.

(4) Special Exercises and General Gymnastics.

The special exercises supplement the work of the massage department, and are adapted to still further strengthen the weakened muscles and muscle groups, as well as to increase the range of joint movements. The weakened or injured muscle or group of muscles being encouraged to act, and assisted in their action by the descent of weight, which has been raised by the sound antagonistic muscles. The repetition of this movement at first is strictly limited, and the weight a light one, but, as progress is made, the weight is increased, and the exercise lengthened. As further improvement is effected, the range of exercises is extended, and becomes inclusive of those in which the weight, light at first and heavier afterwards, is lifted by the affected muscles.

Two types of machines are used, the "pulley and weight," or Benson's, and the "roller and weight." There are eight of the former and two of the latter in regular daily use in the exercise room.

Benson's machine consists of a wooden casing, 8 feet high by 7 inches wide and deep, which is fixed to the wall, and has arms at the upper end, each of which projects horizontally outwards for a distance of 16 inches. The weights are carried in a cage, which is placed inside the casing, and so constructed as to travel easily and smoothly upwards and downwards. The cage and weights are accessible through doors in the front of the casing, and their weight can be varied from four ounces to 100 lb. The pulleys are eleven in number, of which one is placed centrally at the upper end of the casing, and ten are in pairs. The first pair is fixed to the top of the cage, one behind the other; the second is attached to the lower border of the arms, one on each side, near their extremities; and the three remaining pairs are fixed to the sides of the casing, three on each side, the upper pair being situated just below the arms, the middle 3 feet 3 inches, and the lower 3 inches from the ground.

A single rope is used, the two ends of which hang down from the pulleys attached to the arms. The rope from each end ascends to and passes inwards over its own arm and upper lateral pulleys, and then descends inside the casing to the cage, where that from one side passes round the anterior, and that from the other round the posterior cage pulley. Each then ascends to the central pulley, over which they join to complete the rope.

The forms of apparatus capable of being separately attached to the ends of the rope, and in regular use, are :—

(*a*) The handles, for arm and general exercises,
(*b*) The headstall, for head and neck work,
(*c*) The pad, for dorsal and spine work,
(*d*) The bar, for lumbar and hip work, and
(*e*) The ankle and foot straps, for ankle, calf and leg work generally.

With the straps, two additional appliances are used: (1) The stool, for hip and knee; and (2) the small horse, for knee and ankle work.

The straps and the rope attachments generally are used either: (1) Directly from the arm pulleys; (2) after the rope has been brought round the middle lateral pulleys; or (3) round the lower lateral pulleys, depending upon the special exercise required.

The "roller and weight" machine consists of a horizontally placed roller, 20 inches long by 1¾ inches in diameter, which revolves on spindles, about 3 feet 4 inches above ground level. The spindles pierce and are supported by uprights, one on each side. To one of them, which projects beyond the upright, a handle is fixed. Attached to the roller, near one end, is a rope, which terminates in a weight-carrier, and at each end is a ratchet-wheel, the teeth on one wheel being oppositely directed to those on the other, whilst the corresponding ratchets are fixed to the adjacent uprights. By these means the roller can be operated and the rope coiled round it, in either direction. The rollers used are of uniform thickness throughout, but it is preferable, and would be found more useful, to have them graded from 2 inches at one end down to 1 inch at the other.

With these two types of machines the muscles and joints of any part of the body can be exercised to the desired extent. The exercises on the Benson machine, of almost general application, are varied and practically innumerable, whilst those on the "roller" are limited to four different methods of wrist flexion and extension; to digital movements; and, by means of the handle, to supination and pronation of the forearm. In all cases with the weight either assists or resists the movement.

It ought to be mentioned that voluntary exercises performed on a Benson or Abacot machine are in every way superior to the automatic movements obtained by mechanical machines based on the Zander type. For if a joint is so stiff that it cannot be moved or be encouraged to move voluntarily, it is quicker to loosen it, once and for all, under anæsthesia.

Further, the stimulus obtained by the attempt of the patient to move his limb is far more beneficial to the muscles than that caused by automatic machinery. In normal life, no sane man would try to train his muscles for boxing, fencing, or any other athletic event, by the use of a Zander machine, so why it should be considered desirable in cases of muscles debilitated by injury, passes comprehension.

In addition to these various forms of exercise swimming is found to be an agreeable and useful remedy in most cases of crippled limbs, and a contingent from one or other division attends the baths daily.

After the weakness of the special muscles or muscle groups has been definitely overcome, and in those cases where there is non-specialized muscular debility, the proper use of ordinary gymnastic apparatus proves of material assistance in restoring the general tone of all the muscles, and of thus taking its part in the restoration of the lost function.

(5) Splintures.

These are mainly used to correct or counteract deformities, whether resulting from superficial cicatrices, or deeper scar-contracting tissues. In such cases, it was formerly customary to resort to open operations, but our experience has more and more tended to show that such operations are not really necessary, save in some few instances, as practically all scars can be made to yield by prolonged stretching. It is not easy to determine the kind of apparatus, or the method of procedure which will bring about the best results, and no inconsiderable amount of ingenuity and thought have to be exercised in selecting or originating the one, and in deciding upon the other.

These considerations, altogether apart from the space which would otherwise be required, interdict any general description, and suggest some typical illustrations which it is proposed should be drawn from the numerous and not uninteresting finger deformities.

The most common digital contractures met with are those in which the fingers are flexed into the palm, from a cicatrix involving the flexor muscles of the forearm, or from that caused by a wound of the hand itself. These are treated with splintures, after a method similar to that described by Lieutenant-Colonel Robert Jones. Occasionally, owing to the extraordinary tightness of the flexed fingers, it will be found necessary to commence the stretching by the introduction of a "running cork" or cake of soap between the fingers and the palm, which must be gradually increased in bulk, before the fingers can be sufficiently extended to permit the application of the small finger splints.

It should be borne in mind that where a condition of scar-contracted muscle exists, the opposing muscles will have become overstretched. The splints, therefore, should, wherever practicable, be so adjusted that pressure on these weak and lengthened muscles is avoided, whilst

massage and stimulation by electricity or the vibrator can, if necessary or desirable, be carried on without removal of the splints.

A more difficult form of contracture to deal with is where the extensors are involved and flexion becomes impaired. This condition may be so severe that the whole hand is fixed in a position of complete extension. More often the disability is limited to the digits alone, whilst the metacarpo-phalangeal joints are quite free. In the former, manipulation under anæsthesia is often required, followed by contrast baths and free massage, which must be persevered with until sufficient mobility is obtained to permit of the application of some continuous splinture. When treating the latter, in addition to massage and heat, the whole hand is encased in a glove, to the finger-tips of which are attached tapes. These are fastened at the wrist in varying degrees of tension, according to the needs of each separate finger, and the amount which can conveniently be borne by the patient.

Where the limitation of movements is restricted solely or largely to the metacarpo-phalangeal articulations, instead of a glove being worn a very simple contrivance can be made, by which constant flexion of these joints is kept up, being intermitted only for massage and other prescribed treatment. The arrangement is as follows: A small pad is placed in the palm over the metacarpo-phalangeal articulations, and kept in position by a few turns of a bandage. At the wrist-joint a wristlet is worn, to the back of which is attached a piece of webbing, cut approximately to the width of the hand. This webbing is brought firmly over the back of the hand, and buckled to the wristlet in front of the wrist-joint. By these means continuous pressure, in the direction of flexion, can be brought to bear on the fingers at the metacarpo-phalangeal and inter-phalangeal joints.

In wearing these, and other forms of splintures, a certain amount of discomfort or even pain is experienced, which, however, gradually passes off as the scar tissue begins to yield. Owing to this pain patients are apt to loosen or remove their splints, but as soon as they realize that improvement is taking place they invariably do all they can to assist the treatment.

In conclusion, it should be stated that the Almeric Paget Corps, under Miss Mason, are responsible for the massage, radiant heat, and electrical treatment, as well as for the remedial exercises, whilst Mr. Thomson and Lieutenant Stafford undertake respectively the special exercises and general gymnastics; the latter also has taken charge of the swimming contingents.

It is moreover necessary to express our indebtedness to R. F. Colam, Esq., K.C., Recorder of Croydon, not only for making and presenting us with four of our Benson machines, but also for other valued services in regard to our splinture cases.

METHODS FOR THE COLLECTION AND TRANSPORT OF BODY FLUIDS FOR BACTERIOLOGICAL INVESTIGATION.

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Detailed for Special Investigation from No. 4 Canadian General Hospital (University of Toronto).

(*Report to the Medical Research Committee.*)

The exigencies of war have made the bacteriological investigation of the body fluids even more imperative than during times of peace, while at the same time the accommodations surrounding the soldier-patient are frequently less adaptable to bacteriological technique than they are in civilian practice. Consequently it seems desirable at the present time to record any advantageous modifications in the instruments and apparatus used for the collection and transport of such fluids. Improvements to be of value should simplify the technique at the bedside, ensure safety and sterility during transport, and should not necessitate elaborate methods of preparation. Indeed it is most undesirable to have the value and the result of the final investigation at all dependent upon any special care or expertness on the part of the nurse or lay attendant responsible for the original sterilization or for the transport of the material. In this connexion it may be stated, that devices by which sterilization may be carried out in the dry oven or autoclave, and which will leave without further manipulation the apparatus or instrument ready for transport, and convenient for use at the bedside, are the most satisfactory and trustworthy. Particularly is this true for those enjoying the facilities of organized hospitals and institutes, inasmuch as it relieves them of all irksome detail or improvisation. For such metal articles as needles, trocar-canulæ, etc., dry sterilization is preferable, in that any possibility of rusting and blocking of the bore is avoided. It is along these lines and with these points in view that I have attempted to develop the technique.

The general satisfaction I have experienced with the methods to be described (which are an amplification of those previously used by me), is to a great extent now due to the use of quartz glass for certain parts of the apparatus: and as the use of this material, so far as my knowledge or information goes, is not at all general with the profession, I venture to present these methods in full, rather than serve them piecemeal in possible future publications. The particular advantage of quartz glass or silica lies in the fact that it will not break or crack in extremes of heat and cold.

I.—Collection of Material (such as Cerebrospinal Fluid) by Means of Trocar and Cannula.

(1) The danger of contamination in catching fluid, as it flows from the open end of a straight needle or cannula, as well as the difficulty of

avoiding hand contamination incident to the puncture operation, led me to adopt the form of trocar and cannula shown in fig. 1A. The proximal opening of this instrument is ground to fit the nozzle of a syringe, in case the amount of fluid to be drawn is small and not under pressure.

(2) The collection tube or flask of quartz glass is shown in fig. 1B. In my experience tubes so made of glass fail to give satisfaction, and sooner or later break during sterilization. Preparation for sterilization consists in fitting and wiring to the upper arm a short piece of pressure rubber tubing, the open end of which is lightly packed with cotton wool, and in

FIG. 1B.

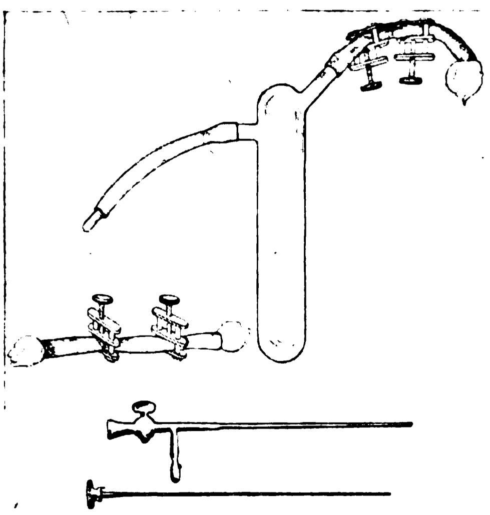


FIG. 1A.

attaching to the lower arm a short piece of ordinary rubber tubing, the open end of which is plugged with a glass rod. This will later facilitate handling at the bedside. At the same time an extra piece of pressure tubing should be similarly packed at the ends with cotton wool. The collection flask thus assembled and the separate piece of pressure tubing should be properly wrapped and sterilized in the autoclave. As four pressure tubing clamps will be required after the tube is filled at the bedside, it is advantageous to tie these to one of the sterilized articles.

(3) Technique at the bedside: the cannula and flask are carefully unwrapped, and the soft rubber tubing slipped on the side-arm of the former. Any possibility of contamination can be avoided by the use of an alcohol flame. Puncture is made with the collecting tube connected in this fashion to the cannula; then the trocar is withdrawn and the tap

turned off. If fluid has appeared at the tap-arm opening, it will readily run through the closed passage-way into the tube. In case the amount of fluid is so small that it does not flow, a sample may be obtained by fitting a syringe into the canula. In making the puncture the collecting tube, so to speak, takes care of itself; afterwards it should be held upright. When the cannula is withdrawn the tubing is pinched with the fingers, and afterwards separated from the arm of the tube. The opening of the arm with any content of fluid thus exposed should be thoroughly flamed, and while hot slipped into the spare piece of pressure tubing, which can be additionally secured by copper wiring, if this is thought necessary. Finally, by tightly screwing down two clamps on each piece of tubing, these passage-ways are effectively blocked. The tube is now packed or carried in any position, and is proof against contamination taking place during transport.

Note.—Cleaning of these tubes is easily accomplished, as any particles or clots not easily washed out can be completely carbonized over a Bunsen or blast flame.

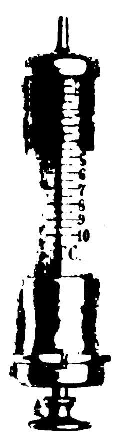


FIG. 2A.

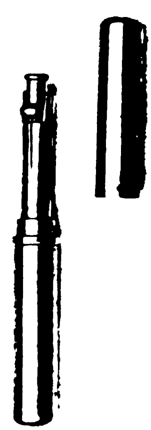


FIG. 2B.

II.—COLLECTION OF MATERIAL (SUCH AS BLOOD) BY HYPODERMIC SYRINGE AND NEEDLE.

(1) The general satisfaction and convenience that would be afforded were it possible to sterilize in the dry oven syringe and needles already packed in their cases, led me to devise the following design of syringe, needle-holder and case.

(*a*) *Design of Syringe* (fig. 2A). So that the parts of the syringe need

not be separated during sterilization, the proximal end of the graduated quartz glass barrel is cemented to a metal collar corresponding in length to the plunger, and of slightly larger diameter to allow for expansion, the collar thus providing, so to speak, a safety extension chamber.

(*b*) *Design of Needle-holder* (fig. 2B).—As shown in the illustration, the removal of either protection cap exposes the head of that needle, so that adjustment to the nozzle of the syringe can safely be made at the bedside. The remaining cap allows one to handle the needle-holder with ease and without risk. In one of the caps there is a small aperture which before sterilization should be adjusted to a similar opening in the inner sheath of the holder to prevent the cap being forced off.

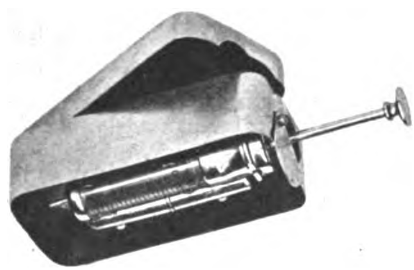


FIG. 2C.

(*c*) *Design of Case, and Adjustment for Sterilization* (fig. 2C).—The illustration shows the syringe with piston extended through an opening in the end of the case, so that the plunger rests in the safety chamber. It is advisable to pack cotton around the needle-holder and syringe before replacing the top, and sterilizing. As soon as cooling has taken place after dry sterilization, the piston is shoved home into the barrel with sterile forceps, sterile wool inserted or not, as desired, and the opening closed by the shutter. This shutter is so constructed that it is with difficulty opened while the lid is on the case. Sterilization in the manner described ensures that everything within the case is sterile, and, moreover, the syringe and needles will later be found convenient for use at the bedside.

(2) Flask for transport of blood in fluid state (fig. 2D): To the side-arm of an ordinary filter flask (containing citrate solution) is attached and wired a short piece of pressure rubber tubing, the open end of which is plugged with cotton wool. The mouth of the flask is stoppered with a well-fitting rubber cork, which is additionally secured by crossed copper

wire. After sterilization in the autoclave, the tubing is blocked by two pressure tubing clamps, and the cork paraffined.

(3) Technique at the bedside: As everything within the syringe case is sterile, the syringe intact and ready for use, and as the head of the needle can be exposed with safety and ease, the adjustment and use of the syringe and needle is very simple. Any possibility of contamination is fully excluded by the use of an alcohol flame. To discharge the blood from the syringe, the needle, on withdrawal from the vein, and while still attached to the syringe, is heated and pressed through the cork of the flask. Both clamps on the rubber tubing should be released before depositing the blood, and afterwards re-tightened. The flask may now be packed for transport.

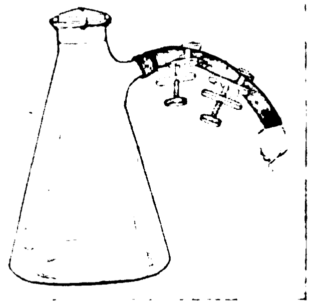


FIG. 2D.

Note.—Beside the individually desired materials for skin sterilization, very few articles need be carried to the bedside when the above methods are used. Thus for the first type of operation the only necessary articles are: (1) wrapped sterile trocar and canula; (2) wrapped sterile flask and extra piece of tubing; (3) spirit lamp. For the second type: (1) sterile case of syringe and needles; (2) sterile flask containing citrate solution; (3) spirit lamp.

My experience with these two types of collecting flasks might be generalized by stating that all specimens of cerebrospinal fluid and blood, collected as described from seven patients, showed no contamination after a transport from the North of Ireland to London; and that material shaken and immediately incubated remained sterile.

III.—FLASK FOR DISTRIBUTION OF STERILE ENRICHMENT FLUIDS IN QUANTITATION AMOUNTS TO CULTURE TUBES (fig. 3).

The subsequent bacteriological investigation of the body fluids is so closely connected with their collection and transport that a brief reference

to a device dealing with this aspect may be regarded as within the scope and intention of this paper.

The purpose of the flask is to provide a sterile receptacle, so that enriching fluids can easily, and without risk of contamination, be distributed quantitatively to tubes of the ordinary laboratory media. And

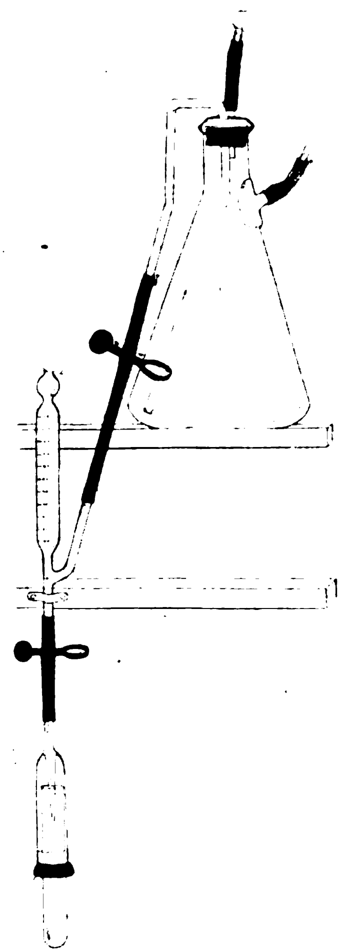


Fig. 3.

some such method is almost a necessity if the work is not routine in character. In this part of the work, as well as in the collection of body fluids, simplification in the technical detail is the surest method of incorporating bacteriological examinations with the practice of medicine.

The arrangement of the apparatus consists in attaching to a large filter flask a graduated tube by means of pressure rubber tubing, as shown in fig. 3. The tightly fitting rubber cork of the flask is pierced by a wool-plugged air vent and the glass tubing (for siphonage), which is connected to the graduated cylinder. This cylinder plugged with wool at the top leads by means of pressure tubing to a hooded pipette, which is protected by a test-tube held in place by a cork in the manner shown by the illustration. It is safer if all rubber tubing connexions and the cork are wired, and after sterilization paraffined. As the different fluids must be obtained sterile, or rendered so by filtration or other means, the flask thus fully assembled is sterilized before being filled through the side-arm, after which this side passage-way is properly blocked by a heated rod or tube, and clamped. Once the flask is filled, siphonage is obtained by forcing air through the air vent and releasing the clamp to the graduated chamber. As the hooded pipette is made of quartz glass, there is no danger of cracking during the necessary use of the Bunsen flame before and after the withdrawal of fluid.

Note.—A properly filled flask may quite safely be forwarded, provided all three exits are additionally clamped, and of course breakage guarded against by careful packing.

Flasks of 500 and 1,000 cubic centimetres filtered horse serum have been completely emptied in from two to four months by adding at irregular intervals the enriching fluid to tubes of culture media, and have remained uncontaminated throughout. The following precautions are suggested on the avenues of infection that might be overlooked :—

(1) In refilling the graduated tube, care should be taken that the fluid is not allowed to reach the cotton wool of the air vent. (2) The tube to which the enriching fluid is to be added should be thoroughly flamed before being inserted within the hood, so that there is no possibility of the discharging tip becoming contaminated from the inner wall of the tube. The test-tube protecting the tip and blocking the mouth of the hood should be treated in the same way before being reinserted.

A NOTE ON DIPHTHERIA CARRIERS.

By Captain A. GREGOR.

Royal Army Medical Corps (Territorial Force).

The value of searching for and isolating diphtheria carriers among troops is well illustrated by the following cases :—

Two cases occurred in T—— Camp, one on November 1, and the other on November 8, 1916. The unit to which the men belonged supplied guards to an outlying station, St. A——, and there was a continual coming and going between the two camps. Four cases occurred at St. A——, on November 8, 22, 25 and 28, respectively.

All hut contacts were swabbed on November 8; in the case of T—— Camp, a carrier was found, whose swab teemed with *Bacillus K.-L.* He had never had diphtheria, nor had he been in contact with a case, as far as he was aware. He did not develop it during his carrier period, which lasted seven weeks.

On November 28, at St. A—— Camp, another carrier was discovered with exactly the same history as the first one. He was a carrier for five weeks. No other cases of diphtheria arose in either of those camps after these men had been isolated. These facts are so striking that comment is needless.

CASE OF PERFORATION OF THE STOMACH AT THE MILITARY HOSPITAL. (OPERATION.)

By Lieutenant-Colonel J. R. YOURDI.
Royal Army Medical Corps (R.).
and
Surgeon Lieutenant-Colonel P. B. BENTLIF,
Royal Militia, Island of Jersey.

Serjt. S., aged 41, was admitted into hospital on April 11, 1916, in a collapsed condition, suffering from great pain in the stomach.

History.—Soon after dinner the previous day he felt "something go suddenly in his stomach"; he had great pain during the afternoon, which became worse during the night; he reported sick next morning, and was seen by the medical officer, who seeing the gravity of the case sent him at once into hospital.

Admission.—Patient admitted *in extremis* complaining of acute pain in the epigastric region, pulse feeble, fluttering, hardly perceptible at wrist, 100. Temperature 100° F. Surface of the body cold and clammy, especially extremities. Skin moist and covered with a clammy sweat. Respirations shallow. No vomiting. Abdomen retracted and hard and great pain in epigastrium on palpation. Liver dullness obscured.

Operation.—Chloroform having been administered an incision was made in the middle line about four inches in length from the ensiform cartilage to the umbilicus, and on opening the peritoneal cavity some bubbling of gas through the opening was detected. No fluid was seen in peritoneal cavity. The stomach was now pulled up and examined and by searching along the lesser curvature a small opening the size of half a split pea was discovered about an inch from the pylorus, the opening being plugged by a small *piece of cabbage.* The perforation was secured by Lambert's sutures, and a small piece of omentum was then placed over the suture line and fixed by four interrupted stitches. The peritoneal cavity was mopped out with a hot moist swab, a drainage tube inserted, the wound stitched up, and dressed with antiseptic dressing, the operation lasting

half an hour. A saline was now given and patient placed in bed in the Fowler position.

April 12.—Temperature 99° F. Pulse 104. Has passed a fairly comfortable night, complains of slight pain at seat of wound. No vomiting. No flatus passed. Given a little milk and water by mouth. Wound dressed, very little discharge.

April 13.—Drainage tube removed, wound dressed, very little discharge. Temperature 99·4° F. Pulse 100. Tongue dry. Some flatus passed *per rectum.*

April 14.—Temperature 98° F. Pulse 82. Passed a good night. Bowels acted after enema. Milk and water taken. No vomiting. No pain.

April 17.—Temperature 98° F. Pulse 88. Has passed a good night. Wound dressed. Feels hungry, given milk, beef tea, and one egg.

April 21.—Temperature 98° F. Pulse 88. Stitches removed, wound healed. Now taking more food. No pain.

April 24.—Patient allowed to get up for a few hours. Sleeps well. Chicken diet with extras.

April 28.—Improving. No pain on palpation of abdomen. Cicatrix sound. Bowels regular.

May 8.—Discharged hospital, cured, to sick furlough.

May 20.—Is now quite well, gaining flesh, and no pain after eating.

Remarks.—This case illustrates the hopefulness of an operation on a chronic gastric perforation, even after twenty-four hours' delay, compared with an acute perforation under similar conditions; also the value of the method of using a piece of omentum to cover the site of ulceration where the wall of the stomach is in an unhealthy condition from chronic inflammation.

TRISMUS OCCURRING DURING AN ATTACK OF SERUM SICKNESS IN A PATIENT CONVALESCENT FROM A SEPTIC FINGER.

By Captain R. F. BOLT.
Royal Army Medical Corps.

An officer of the Royal Army Medical Corps, doing duty at a Casualty Clearing Station, pricked his right index finger on March 1, while operating on a case of empyema, the result of a gunshot wound of the chest. On the following day his temperature rose to 102° F., and the finger was incised. On March 3 a dose of eighteen cubic centimetres of antistreptococcus serum was injected into the right flank. No antitetanic serum was injected. In the evening his temperature rose to 104° F. On the next day the temperature was 102° F., and it fell to normal on the following day.

On March 7 he was transferred to a General Hospital, where he came under my care. On admission the wound in the finger was healed. There was a tender enlarged gland in the right axilla. The temperature was normal and remained so for seven days. The gland subsided. He was up and going about and was marked fit for a Convalescent Home, but on March 14 he developed an urticarial rash on the arms and chest and abdomen. On the 15th the rash was distributed generally over the body; there was severe headache, and the temperature rose to 100° F. On the morning of the 16th the temperature rose to 102° F., and he had great pain in the neck, back and limbs. He complained of stiffness in various muscles; there was also some rigidity, especially in the right upper limb. The lower limbs were drawn up and could not be fully extended. The metacarpophalangeal joint of the right middle finger was swollen and very tender. He was given a mixture containing twenty grains of sodium salicylate and twenty grains of sodium bicarbonate, to be taken every four hours. There was then profuse sweating, the eyes were congested, and the same evening trismus developed; the teeth could only be separated by a quarter of an inch. There was no sore throat and no local inflammatory condition of the jaw or mouth.

The case was seen in consultation by Colonel A. Fullerton, A.M.S., and Major A. E. Webb-Johnson, R.A.M.C. The possibilty of the symptoms being due to tetanus was seriously considered, but it was decided that, as the patient was already suffering from serum sickness, it was not advisable to give antitetanic serum, but that other methods of treatment should be tried. Accordingly, the patient's room was darkened and he was kept very quiet. He was given twenty grains of chloral hydrate at 7 p.m. and again at 11 p.m. The pain continued and he was given $\frac{1}{4}$ grain of morphia at midnight. The sodium salicylate and sodium bicarbonate mixture was continued.

On the morning of the 17th he was a little better, temperature 102° F., the trismus was less marked, and the pain was subsiding. Chloral hydrate (twenty grains) was repeated four-hourly, alternately with the sodium salicylate mixture during the day. There was still considerable anxiety as to whether the symptoms were due to tetanus, or whether they could not be entirely accounted for by the serum sickness.

On the 18th the trismus had almost disappeared and the muscular pains were less severe. He had one dose of chloral hydrate (twenty grains) during the day.

On the 19th he could open his mouth to the fullest extent. The temperature was normal, and the pain had disappeared. Further progress was rapid and satisfactory. He was allowed up on the 23rd, and went to a Convalescent Home on March 25.

If the symptoms were due to tetanus the infection might have taken place at one of the following times:—

(1) When he pricked his finger. Inquiry showed that the patient on

whom the operation for empyema was performed made an uneventful recovery. But as he had received an injection of antitetanus toxin, it is possible that tetanus bacilli were present in the wound.

(2) When the finger was incised. This is almost unthinkable at a place where there is constant operating, and a regular surgical technique.

(3) From the needle, when the antistreptococcus serum was injected. This also is unthinkable.

(4) The serum might have contained some tetanus toxin. This is possible, but unlikely, otherwise one would expect to have heard of other cases of a similar character.

The course of the symptoms and the rapid recovery point to the condition having been due entirely to the antistreptococcus serum. The occurrence of trismus fourteen days after the infliction of a wound is calculated to give rise to great anxiety, not to say alarm, and I thought the case might be of interest to others.

I am indebted to Lieutenant-Colonel T. H. Goodwin, C.M.G., D.S.O., R.A.M.C., for permission to publish this case.

TRENCH PYREXIAS: THEIR PREVENTION AND TREATMENT.

By Captain B. HUGHES.
Royal Army Medical Corps (Territorial Force).

During August, 1915, and the succeeding months, "pyrexia" was of common occurrence among officers and men who were either living in trenches or billets (usually deserted villages) close behind the firing line.

Prior to August, the cases occurring regimentally were very few indeed compared with those seen during the winter months, and this rather suggested that flies, which were numerous about the trenches during the summer months, had very little to do in the propagation of the diseases of which this pyrexia was a symptom. There seemed to be no predilection for men attacked.

The pyrexia was sufficient to render a man temporarily unfit for duty, and while in trenches these men were at first sent to the field ambulances. The diagnosis made in a number of these cases was pyrexia N.Y.D. (not yet diagnosed). Some were sent to casualty clearing stations, evidently suspected cases of paratyphoid infection, others after a week's rest were returned to their units, only, in quite a percentage of cases, to relapse. A noticeable feature during the later months of the year was that, when once started, how rapid was the spread of this pyrexia, and the serious problem arose as to what should happen if the disease became epidemic.

A search and inquiry were then undertaken to ascertain the cause—it

could not be ascribed to the water, or the food, judging by the condition in which the latter reached the trenches. Trenches and dug-outs were investigated, and the histories and symptoms of the men suffering with pyrexia were thoroughly gone into. There appeared to be three diseases associated with pyrexia differing clinically, and briefly they are as follows:—

(*a*) Preceding the onset there is a feeling of malaise with, in some cases, slight soreness of the throat. This usually lasts some thirty-six hours. It is followed by pyrexia, often 103°, but rarely higher—headache, anorexia, and a feeling of having been "beaten all over." These symptoms were invariably accompanied with constipation, the bowels not having moved for three or four days, sometimes longer.

The condition resembled in almost every detail what in England is known to the laity as "flu."

It is difficult to ascribe a cause to this disease, but it must be remembered that these men were living in trenches under trying conditions, and, further, while in trenches there is a tendency for men not to go to the latrine. A number of men have been hit while on the latrine, and others in consequence prefer to wait until they come out of trenches.

Hence constipation coupled with trench life might act as a strong predisposing factor.

Treatment.—A smart purge in the form of pil. 9, with mag. sulph. two drams, followed by sod. salicylate ten grains t.d.s., rapidly brings down the temperature and disperses the symptoms. An iron, arsenic, strych. and quinine pil. given three times a day after food for three or four days is sufficient.

The condition shows no tendency to recur, and I have not found it necessary to send a man to hospital.

(*b*) The symptoms of this class are:—

(1) Extreme sudden onset by day or night.

(2) Pains at the back of the eyes, with dizziness and often a fainting fit.

(3) Pain in the "shin bones," thighs, and small of the back.

(4) Pyrexia ranging from 103° to 104°.

(5) A rapid and often irregular pulse.

(6) Profuse sweating.

A noticeable feature about this class of case is the clean, moist tongue. These men can take food and digest it. Constipation and diarrhœa have been present with equal frequency; rarely have the bowel functions been normal.

Men suffering with this complaint show a marked tendency to relapse, even after eight or ten days.

The period of incubation is, I think, short, though this is difficult to say with certainty. Contacts, however, have invariably reported with the symptoms well established thirty-six to forty-eight hours after removal of the affected case. This was the general rule.

Cases with these symptoms sent to field ambulances returned at the end of a week, and such cases invariably relapsed.

An excellent and most interesting article appeared in the *British Medical Journal* of February 12, 1916, by Capt. J. W. McNee, R.A.M.C., and his colleagues, describing this disease. These observers conclusively prove that it may be excluded from the typhoid group; they also noticed its contagious nature, and their work goes to prove that it can be transmitted from man to man through the corpuscles.

The rapidity of the spread of this particular condition in trenches and billets close behind the firing line was one of the serious problems with which regimental medical officers were faced. With regard to its causation there are the following facts:—

(1) The occurrence of the disease was greatest during the time that conditions in the trenches were worst.

(2) On getting back to clean huts in the rest billets, where the men could get a bath, a change of clean underclothing, and could have their uniforms and blankets disinfected, the number of cases fell immediately.

(3) On coming away from trenches for a month, where personal hygiene could be thoroughly carried out, it was a simple matter to eradicate it.

There is, therefore, I think, strong presumptive evidence that this is a louse-borne disease, for whenever it was possible to carry out measures for the eradication of lice, the number of cases invariably fell to a minimum.

A further noticeable feature about this class of case was that as soon as the temperature fell these men were fit to resume duty; the pyrexia and sweating did not "take it out" of the men to anything like the extent that one would have first imagined. This I noticed especially in my own case.

As the numbers of the unit had dwindled, I decided to treat these cases regimentally, and also to adopt prophylactic measures for men who had not been affected.

Treatment.—The main treatment aims at prevention, and this can best be done while men are in rest billets.

The first step is to eradicate lice, scabies, and pediculosis pubis. The men are sent to the baths, procure clean underclothes, and also have blankets and uniforms disinfected; at the same time an inspection for scabies and pediculosis pubis is carried out, and these, if present, get appropriate treatment,

Each man is given a purge in the form of a No. 13 pill, and five grains of quinine sulphate are given in the evening. This is repeated the following evening, and on the third evening quinine sulphate two grains is given to each man.

This treatment, though simple, proved a most satisfactory preventative

measure, and the result was an occasional sporadic case in a mitigated form.

When once the disease has established itself, the two drugs par excellence have proved to be quinine and sod. salicylate. These men are given a brisk purge in the form of two No. 9 pills, quin. sulphate 15 grains and sod. salicyl. 15 grains are given with brandy 1 ounce. The temperature invariably falls in twenty-four hours with a sweat. If the quinine is borne well, a further ten grains are given the next day, and Dover's powder ten grains with it.. On the following day quinine five grains is given. With each dose of quinine sod. salicyl. ten grains is administered.

After this for four or five days the iron, arsenic, strychnine, and quinine pill is given three times a day.

With this treatment there has been no relapse.

The most persistent symptom is the pain in the shins, but with massage, and allowing the soldier the use of linamentum terebinth. this aggravating symptom gets less, and disappears about the fourth or fifth day.

(*c*) This class of case shows a pyrexia ranging from 102° to 103° F., and is associated with an acute form of diarrhœa, with blood and mucus in the stools.

This was especially prominent during the winter months. There was no tendency to relapse, and the temperature rapidly came down to normal with treatment.

The food and water were carefully investigated, and nothing could be found here which would cause the disease.

I think a possible explanation might be found in the trench rat.

This rat is a large coarse animal, very foul smelling, and evidently living on decomposing organic matter. Occasionally these vermin would attack any food that was lying about, but invariably they showed a preference for decomposing organic material.

On one or two occasions there was noticed an epidemic of disease among them, and this was associated with a desire for water. They could be seen drinking the water from shell-holes, and it was apparent that they were in a diseased condition. Frequently a number of dead rats would be found in the open in the morning.

These rats would creep into the dug-outs for warmth, and often soldiers have awaked to find one of these animals asleep under their blanket. On one occasion a signaller awoke to find a rat asleep on his neck, and on another occasion another man was awakened by two rats fighting in the space between himself and his comrade.

It will thus be seen how fearless of the human being these animals are, and therefore how near they could come to disseminating any infectious fleas or material that they might carry on their bodies. They are very numerous, and I think it highly possible that they may be the cause of

this type of pyrexia associated with diarrhœa. This, however, needs confirmation.

Treatment.—One ounce of castor oil is given to start with. As soon as this has been effective, chlorodyne 1 dram in 1 ounce of brandy is given, with bismuth salicyl. fifteen grains three times daily. If the diarrhœa persists, twenty minims of the tinct. camph. co. is given with the bismuth.

As a rule, both diarrhœa and temperature rapidly subside, and there is no recurrence.

SHELL-SHOCK AND ITS TREATMENT BY CEREBROSPINAL GALVANISM.

By Captain WILFRED GARTON.
Royal Army Medical Corps.

The term shell-shock is made use of to describe two distinct conditions, one a severe type of traumatic neurasthenia, and the other bearing no resemblance to a neurasthenic condition but characterized by hysterical manifestations.

It is for shell-shock of the neurasthenic type only that cerebrospinal galvanism is of service as a treatment, for its use being based on the assumption that neurasthenia is an organic disorder, there is no reason to expect any favourable results to follow its use in a condition of functional disorder.

In the neurasthenic type of shell-shock, most, if not all, of the following symptoms are found to be present: headache (always aggravated by the advent of thundery weather), insomnia, mental depression, loss of memory, nervousness, bad dreams, fatigue (without exertion), tremors, wasting and loss of appetite. Paralysis of limbs or groups of muscles and localized pains are also present in a number of cases. The resemblance between this condition and neurasthenia following severe illness is so striking that a similarity of origin is exceedingly probable.

Any one of the above symptoms appearing separately might be looked upon as a functional disorder, but the co-existence of all or nearly all of them in a series of cases, admits of only one explanation, if the simplest explanation is the most probable, and that is that they are the effect of a common cause, organic disorder of the central nervous system, and as there is no gross lesion, this is probably a disarrangement of metabolism. Furthermore, the character and personality of the patient are greatly changed by this condition, and it is inconceivable that this alteration can take place independently of any structural damage or metabolic disturbance in the organism from which the character and personality take their origin and depend on entirely for their continued existence.

A possible explanation of the appearance and persistence of the symptoms is, that the violent concussion of the explosion produces a partial paralysis of the nervi nervorum. The interference with the nutrition of the whole nervous system would prevent the restoration of the nervi nervorum to their normal activity and thus the evil would be acting in a circle. This would account for the resemblance between these cases of shell-shock and cases of neurasthenia following severe illness, for a partial paralysis of the nervi nervorum might be produced by the action of toxins.

The cure of neurasthenia by suggestion in some cases is not an inexplicable contradiction, for it is conceivable that the paralysis of the nervi nervorum may be of just that extent that recovery is only prevented by the mental depression consequent on the condition maintaining a state of lowered vitality. In such cases relief from the mental depression would result in a cure.

Now if there is any probability that shell-shock of the neurasthenic type is due to a paralysis of the nerves regulating nutrition or a disorder of metabolism, then the use of the galvanic current is a treatment from which one has every reason to expect good results, for the most powerful agent we have for stimulating the nerves to activity is electricity.

The best form of apparatus for giving this treatment is a battery of wet Leclanche cells connected to a switchboard on which are two resistances, each of 1,500 ohms, one in series and the other in parallel with patient and milliamperemeter. The treatment is then commenced with no resistance in parallel and full resistance in series. The parallel resistance is first increased to its full extent and then the series resistance diminished until the required amount of current is obtained. If this apparatus is not at hand, a battery of twelve dry cells with cell collector and galvanometer and a resistance of at least 1,500 ohms may be used. No current derived from the mains of any universal apparatus should ever be used for this treatment. A pad composed of about sixteen layers of lint, soaked in a solution of salicylate of soda in distilled water is applied to the forehead, care being taken that the pad is evenly wetted and that its centre coincides with the middle line of the forehead. Over the centre of the pad is placed a metal plate and the whole firmly bandaged to the head. The metal plate is connected to the negative pole. A pad of the same thickness, about ten inches by six inches, is soaked in tap water, covered with a metal plate and firmly bandaged to the lumbar region. This is connected to the positive pole. The current is increased very slowly, taking about twenty minutes to attain the maximum of twenty milliamperes, at which point it is allowed to remain for twenty minutes and then is slowly reduced to zero. When increasing the current the cell collector is advanced before reducing the resistance, and when decreasing the current the resistance is used first.

For a first treatment I give only ten milliamperes for ten minutes

and do not pass the full strength of current, twenty milliamperes, till the third or fourth treatment.

With patients who are nervous of electricity, I find it a good plan to give labile galvanism to the spine for two or three days before commencing cerebrospinal galvanism.

Having found this treatment successful in cases of neurasthenia shortly after joining the Service, I treated several cases of shell-shock by the same method. Unfortunately, I was unable to keep these patients under my care for a sufficient length of time to effect a cure, but in every case I was impressed with the rapid progress made towards recovery. I had no further opportunity of treating this condition until the end of last February.

My first patient had not suffered by a shell explosion at close quarters, but he had been exposed to shell fire in the trenches for a considerable time, and as he showed most of the symptoms of shell-shock, I think the case worth recording, although it was not of a severe type.

Pte S., age 34. Constantly exposed to shell fire during the latter half of last year. When first seen he was suffering from pain in the back and legs, tremors, headache, fatigue without exertion, nervousness, insomnia, mental depression, wasting and loss of appetite. Cerebrospinal galvanism was commenced on February 23, but after three treatments his regiment was moved to another district. He was transferred about a month later to a home service battalion and, being stationed in this district again, asked permission to continue his attendance at this hospital as he had derived so much benefit from his treatment here. The treatment was again given three times a week for five weeks. At the end of that time he had gained considerably in weight, the tremors had disappeared and he stated that he felt quite well except for the pain in his legs which had increased. I took an X-ray plate of his legs, which showed a syphilitic condition of the bones. Treatment for this condition was carried out by the medical officer of his regiment, and he now feels perfectly well.

Pte. H., age 30, was knocked over and buried by a mine explosion on December 12, 1915. He was unconscious for some hours. He was in a V.A.D. hospital for a month after arriving in England and then returned to his regiment for light duty. He was still exceedingly nervous and was so distressed by being placed on guard on a railway that he reported sick. When first seen he was evidently in an extremely nervous condition, and very depressed mentally. He complained of bad dreams, want of sleep, loss of memory. He was also suffering from severe headaches, fatigue and loss of appetite. He was considerably wasted. Cerebrospinal galvanism was commenced on March 25. After four treatments he was sent out of hospital, owing to an error, as fit for duty. His medical officer was communicated with, and as the patient was very

much better he was allowed to remain on light duty and received treatment again on April 5 and 7.

On April 8 he received news of the death of one of his children and had no recollection of what happened afterwards until he found himself in Birmingham. About twelve days later he reported to the nearest police station that he was absent from his regiment without leave. He came to this hospital again on May 1 and was admitted. Treatment was recommenced, and by the end of May he had gained about 1½ stone in weight and appeared to be in perfect health. Treatment has been continued up to this week as a precaution against a return of the condition.

Serjt. P., age 37, was blown up by a mine explosion on July 27, 1915. He was unconscious for fifteen hours. On recovering consciousness his left lower limb was found to be paralysed, and it remained so for five months. He was treated at a military hospital for four months, where he was given electric baths, and then removed to another military hospital where he remained for three and a half months, being treated daily by massage, faradism, radiant heat and ionization. He left there on March 25, at his own request, to return to light duty. He reported sick again on April 7. When first seen he was suffering from headache, insomnia, bad dreams, loss of memory, tremors, pain in the lumbar region, mental depression and fatigue without exertion. He stated that he had lost flesh early in his illness, but had regained his normal weight, and that his headache was less constant than at first, though undiminished in intensity. He has been treated three times a week by cerebrospinal galvanism since April 22. He has now perfectly recovered from loss of memory and mental depression and exhibits no tremor. There is very little nervousness. He still suffers from slight headache in the morning. He is sleeping fairly well and is not much troubled with dreams. He suffers from fatigue, but far less than when treatment was commenced. The pain in the lumbar region is not much improved, but in every other way he is making steady progress. While under treatment he has been doing clerical work continuously.

Sapper M., age 30, was blown up by a mine explosion in September, 1915. He was unconscious for ten hours. He had the usual symptoms of shell-shock, but tremor all over the body was particularly prominent. There was also drop wrist on the left side. After three months in a military hospital he returned to light duty. His condition gradually became worse again and he reported sick about the middle of April. When first seen tremor was very noticeable. He complained of headache and insomnia which had not diminished at all while under treatment. There was also loss of flesh, muscular weakness, loss of memory, mental depression and bad dreams. He reported sick on account of the tremor increasing and persistence of paralysis of his forearm. He has now had six treatments by cerebrospinal galvanism. He is sleeping well and has

only slight headaches occasionally. The tremor has disappeared, his memory is good and he is quite cheerful. Some voluntary movement returned to the extensors of the hand and wrist after treatment of the spine by labile galvanism, and the power of movement is increasing, although he has had no local treatment for these muscles.

The conclusion I have arrived at from the trials I have carried out of this treatment is that nearly all cases of the neurasthenic type of shell-shock would derive great benefit from it, and the majority of cases, excepting those of the most severe type, would be cured in under three months.

DEVICES FOR THE DISPOSAL OF WASTE WATER IN CAMPS.

By Captain G. W. ELLIS.
Royal Army Medical Corps (Territorial Force).

The sanitary requirements of camps of some months or perhaps years duration, which are, however, not constructed on a permanent basis, have, like many other military matters, become more manifest since the outbreak of war. For temporary field camps, and for permanent ones, a guide as to these requirements can be obtained from the existing handbooks on camp sanitation, but the large number of base camps in existence at the present time make their requirements more deserving of attention than has been the case in the past. I venture to believe that the sanitary structural work carried out at a large base camp will furnish some useful information on this subject. We have been under the necessity of finding by experience satisfactory methods of dealing with these problems, and the form of appliances that have eventually been adopted are of so successful a nature that I am induced to give some account of these in the hope that they may be of service to others. I am introducing no new principles, but rather what I consider to be the most satisfactory forms of apparatus that can be economically placed in field camps, which in all probability are destined to be occupied for the duration of the War, but are supplied with no drainage system. They are limited in space, and are under the necessity of getting rid of their refuse within their own area. The upper surface of the soil consists of about two feet of sand, under this is solid chalk, not readily absorbent.

The congestion of these camps renders it most necessary that the ground be kept in as clean a condition as possible. The carriage of waste liquids into underground spaces without fouling of the surface earth is a problem presenting difficulties which I do not think can be appreciated except by those that are familiar with the practice of dealing with such matters.

The subjects can be divided into three sections:—

(1) The disposal of excreta.

(2) The disposal of kitchen waste.

(3) The disposal of ablution water.

The Disposal of Excreta.

It is understood that in such camps as are under consideration, any form of open trench is impossible. Excreta must either be carted away or burnt. It is almost invariably burnt, along with the general camp rubbish. The difficulty of combustion is not very great, especially if the supply of wood or coal is not too limited. I wish however to confine myself to the disposal of waste liquids. The separation of the liquid from the solid excreta, and the disposal of this, and of the contents of urine pails, are operations not easy to perform without fouling the ground. When the incinerator is built upon a concrete floor a hole in this, leading by a pipe into the soakage pit, serves admirably. If, however, no concrete floor is available, a hopper has to be constructed. The simplest form is a shallow square shaped funnel of not less than two feet diameter, so that the bucket can be placed inside the hopper before being tipped up for the purpose of pouring off the liquid portion.

Another form which I have found satisfactory is shown in fig. 2, and is two feet long by eighteen inches wide.

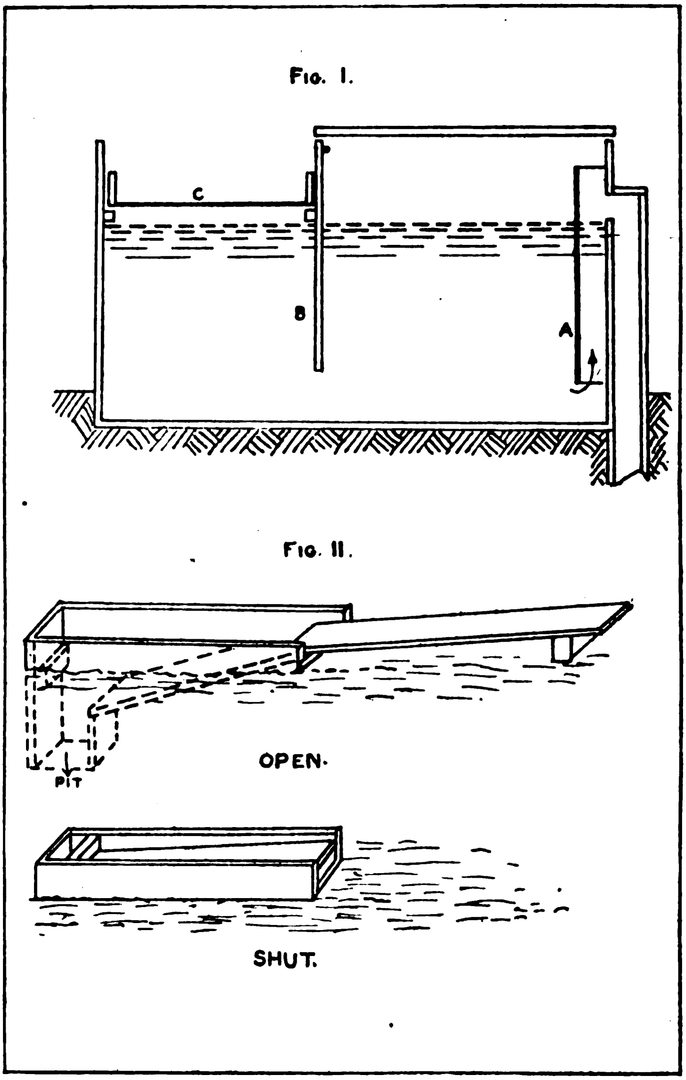
The lid is hinged on by a couple of stout screws, and serves as a rest to the bucket, so that any drippings flow down into the hopper portion of the contrivance, which is kept well tarred. The practice of filling pits with the innumerable burnt tins, which are available in large quantities in most camps, has, I believe, become very general. The tins are preferably pierced. The top layer of tins is covered with old cloth or sacking, and about a nine-inch layer of earth forms the upper covering.

The Disposal of Kitchen Slops.

This problem presents the chief difficulty mentioned in the preceding paragraph, viz., the emptying of dirty water into pits, and at the same time avoiding surface pollution.

For a camp in continual use, the short earth trench filled with straw or stubble is not satisfactory. Something of a more lasting nature is advisable. At the same time the objects of the grease trap have to be fulfilled, the removal of grease which is so fatal to the life of a soakage pit, and the removal of solid matter. Moreover, the inlet to such a trap must be of a sufficient size as to allow of the emptying of large cauldrons of hot greasy water without spilling, and the trap itself of such proportions as to retain and cool large quantities of hot greasy water and so prevent the melted grease from being swept through into the pit. The difficulty of obtaining a good supply of a combustible filtering medium for

such traps, and the difficulty of combining efficiency of filtration with the required permeability, have led me to abandon any further attempts at filtration, and to adopt a grease box as shown in fig. 1. This box is about



four feet long by two feet wide, and has a depth of about two feet. It contains a baffle plate (B) coming to within six inches of the bottom of the box. In front of the outlet is a piece of bent tin (A) serving as a

second baffle. The shape of this is more clearly understood by reference to fig. 3. The contrivance is kept well tarred.

A movable tray (C) serves to retain the coarser solids, but its perforations, unless of fair dimensions, are readily choked up.

The sanitary squad is instructed to clear off the grease which collects on the upper surface of both compartments, but more particularly of the first, an operation carried out twice a day. The solid matter collecting at the bottom of this box is removed less frequently. It will be noticed that a considerable quantity of water is retained by such a trap, and that such water serves to cool any hot greasy water thrown into the trap. The box is covered by two lids supplied with handles. Another kitchen requisite which it was considered expedient to instal was a table for the cleaning of mess tins and camp kettles. A handful of sand or clean earth rubbed on a greasy mess tin will produce a clean polished article quicker than any other means.

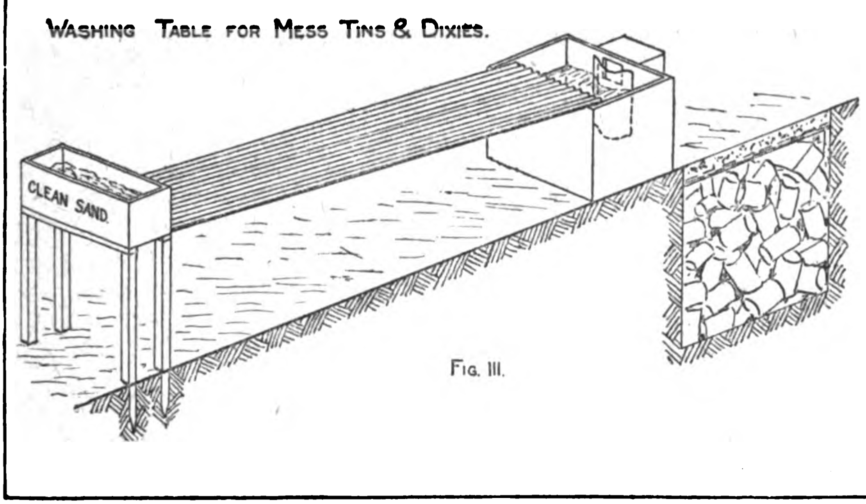


FIG. III.

The soldier knows this and to avoid the fouling of the ground, a simple form of table, made by a piece of corrugated iron, ten feet by two feet six inches, as shown in fig. 3, was constructed. Clean sand is placed in a box every morning.

A simple form of grease trap on the same principle as the one above described is essential, as grease, tea leaves, etc., are washed down the table.

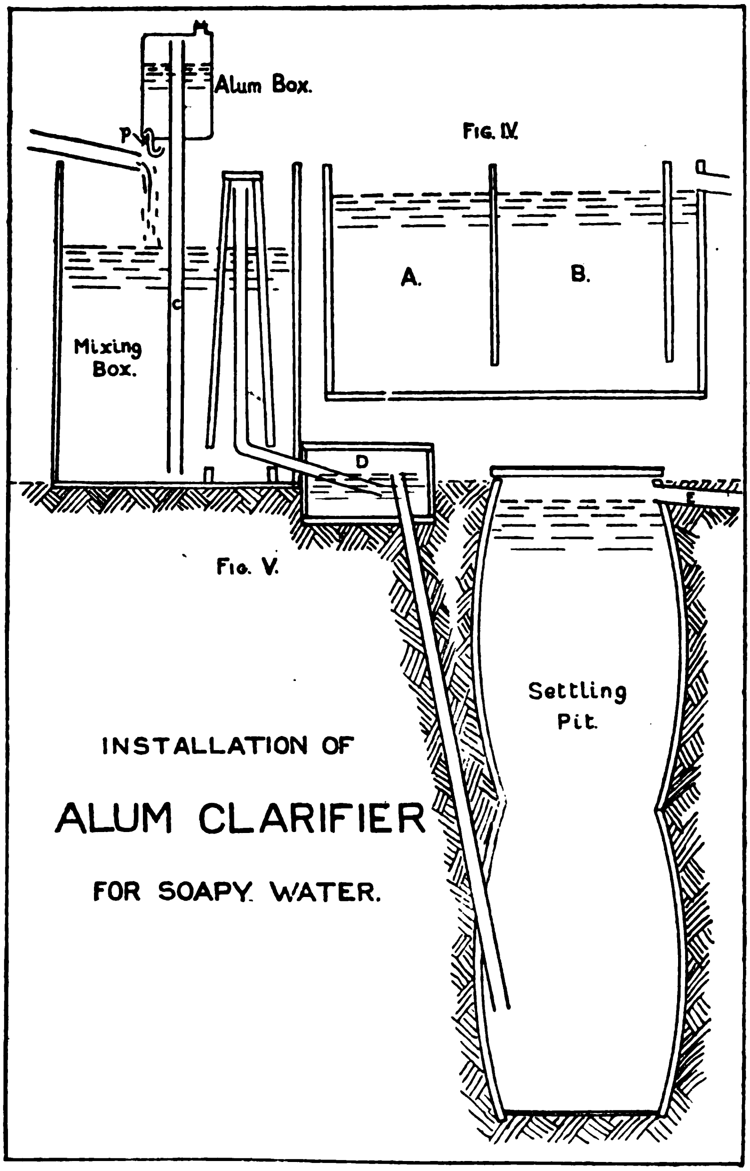
THE DISPOSAL OF ABLUTION WATER.

This, perhaps, is the most difficult problem in large camps where the water supply is not to any very great extent limited. Partly because of the large quantity of soapy water that may have to be dealt with, and partly because of the clogging effect which such water has on most soils. Unless one is content to allow ablution water to lie about in open spaces, over 5,000 gallons may have to be got rid of daily.

I have preferred to keep this water entirely under ground, especially in the summer. Instead of making use of pits, long underground trenches running in the looser upper surface have been much more satisfactory. These trenches are either covered over with odd pieces of wood, or filled with tins, and covered with old sacking and a little earth. It is most impracticable to run soapy water into such underground systems without previously removing the scum which settles on the surface of hard waters which have been rendered soapy. The result of neglecting this precaution is to considerably reduce the absorbing capacity of soakage areas. This scum is readily removed by passing the water through a trap not unlike that described above, for dealing with kitchen slops. Such a trap is shown in fig. 4.

The amount of lime soaps daily removed from the surfaces of compartments (A) and (B) of this box is often as much as two or three buckets full. Such a device does not remove the more finely suspended matter of soapy water, nor is such colloidal matter readily removed by filtration. In my opinion, any attempts at filtration of soapy water are most impracticable without previously passing the water through some such trap as the one described; for the scum of soapy water has the most clogging effect on any filter. If, however, this preliminary treatment be carried out, filtration through sand or coke is possible as in this way the water is partially clarified, but I consider the additional process of filtration is not satisfactory or economical. It is fortunately not often necessary. The colloidal nature of such water does not readily lend itself to a clarifying process, unless some precipitant such as aluminium hydroxide be introduced.

In one case I have installed an alum precipitating process. This was because the ground available for absorption was extremely limited, and a deep well had to be sunk to take the waste water. To avoid the choking of this I considered it worth while to introduc the scheme which is described below. A very much simpler method of adding alum could have been devised, but the main objective was the economy of the reagent. Preliminary quantitative experiments with samples of soapy water from the ablution troughs indicated that about ten grains per gallon of alum was the least quantity that could satisfactorily carry down the colloid. The apparatus constructed required some pieces of two-inch water piping, otherwise the material employed consisted mainly of easily obtainable


Alum Box.
P
C
Mixing Box.
FIG. IV.
A.
B.
D
E
FIG. V.
Settling Pit.
INSTALLATION OF
ALUM CLARIFIER
FOR SOAPY WATER.

articles, such as one or two packing cases and an ordinary square petrol can. This process can be readily followed by reference to figs. 4 and 5. The water is first passed through a trap to remove the scum as previously described. Such a trap is shown in fig. 4. A saturated potash alum solution, containing approximately ten per cent of the crystalline salt or 5·5 per cent of the dried salt, is introduced into the petrol can through its ordinary stopper opening, which is then screwed down. The diagram shows that this solution cannot get out of the pipe *p* unless water is passing into the mixing box. In this case water will rise in the tube *c*, and forcing air up the can will force an equal volume of the solution through the pipe *p*. When this mixing box is full, it automatically syphons out through a trap D, which serves on a constant level, and ensures the proper working of the syphon. From thence the water passes into a settling pit lined by two barrels. This acts as a sedimentation tank, and the clear water flows away by the pipe E. It is preferable to fix a baffle plate in front of this outlet to retain a slight scum which collects on the surface water of this puisard. When the mixing box empties, air is sucked through *p* equal to the volume of the fall of water in pipe c. The S shape of *p* is essential, and it should be as short as possible.

It should be noted that the mixing box is made of such a size that its capacity is the volume requiring the amount of alum delivered by the length of pipe equal to the water depth in the box. It is more easy to make a box suitable to accompany an odd piece of piping, than to obtain pipe of a particular bore. This particular method of delivering an exact amount of alum requires the mechanical filling and emptying of the box, an action most conveniently carried out by means of a syphon.

The bell syphon was constructed of wood with an inner iron pipe. The wood is well tarred and preferably coated with pitch. Such a scheme has been working with little attention for some time. A drawback is the clogging of the pipes with soap. They have to be cleaned occasionally with a large test tube brush mounted on an iron rod or cane.

My thanks are due to Pte. H. E. Gates, R.A.M.C. (T.F.), for his careful preparation of the diagrams of this article, also to Staff-Serjt. W. Gibb, for his able assistance in working out the designs of the appliances here described.

THE SURGICAL USES OF OZONE.

By Major GEORGE STOKER, C.M.G.
Royal Army Medical Corps.

The accompanying tabulated statement of the results of the first twenty-one cases treated by ozone at this hospital cannot be regarded as anything but satisfactory and very remarkable from every standpoint, be it humanitarian, scientific or economic. The cases were, for the most part, those of cavities and sinuses in the femur and tibia. It is the experience of those who have seen a great deal of war surgery, that such cases obstinately resist treatment and are apt to remain unhealed for months and years.

The treatment consists in the application of ozone to the affected parts; it is, therefore, necessary to have an apparatus for generating ozone, which shall be portable and easily worked. The one I am accustomed to use is known as Andriolis's ozonizer. It is called into operation by a four-volt battery animating a quarter-inch sparking Rhumkorff coil. The oxygen passes from a cylinder through the ozonizer and in doing so comes in contact with a metal armature, the effect of this being to transform the oxygen into ozone.

The properties of ozone which have a wonderfully healing effect are, as far as one can say at present, three :—

(1) It is a strong stimulant and determines an increased flow of blood to the affected part.

(2) It is a germicide, which destroys all hostile micro-organic growth.

(3) As a French chemist has shown, it has great powers in the formation of oxyhæmoglobin.

The ozone is applied on the wounded surface or to the cavities and sinuses for a maximum time of fifteen minutes, or until the surface become glazed. Ozone has the particular power of disclosing dead bone, foreign bodies, septic deposits, etc. This, I believe, it does by destroying the granulations and micro-organic growths (presumably unhealthy) that are found in close contact with septic deposits, foreign bodies or dead bone.

Cleansing and Dressing.

Wounds and sinuses, etc., are washed twice daily with boiled water and a dressing of dry gauze is applied. It must be observed that at first ozone causes an increase of the discharge of pus; later on the pus is replaced by clear serum, which, at a still later stage becomes reddish or pinkish. In open wounds it is necessary to strip off the parchment-like film that surrounds the edges, and which is composed of oxidized serum. This is easily effected by applying a hot compress for fifteen or twenty

Tables of Wounds: Sinuses treated by Ozone.

	Name, etc.	Nature of disability	Previous duration	Duration of treatment	Result	Remarks
1	J. B., No. 5476, Lincolns	Compound comminuted fracture of femur resulting in cavity 1 inch by 1½ inches, and sinus 1½ inches deep	20 months ..	2 months ..	Cure	—
2	W., No. 15247, Lincolns	Two large surface wounds on forearm, 5 inches by 4 inches	6 weeks.. ..	2 ,, ..	,,	Treatment was discontinued for 4 weeks
3	H. E. B., No. 6292, East Surreys	Three sinuses opening from back of scapula, each 6 inches long	9 months ..	2 ,, ..	,,	—
4	G. G. T., No. 15693 ..	Ulcer on end of stump	3 ,, ..	3 weeks ..	,,	—
5	M., No. 172513, K.O.R.L.	Wound on shoulder	10 ,, ..	4 ,, ..	,,	—
6	M...	Sinus in tibia 1½ inches deep	12 ,, ..	7 ,, ..	,,	—
7	Harry D., No. 6808, Scots Guards	Ulcer on instep	2½ ,, ..	3 ,, ..	,,	—
8	A. A. A., No. 1099, Canadian	Cavity and sinus in femur, 2½ inches deep	14 ,, ..	2 months ..	,,	—
9	F. G. B., No. 2137, Grenadier Guards	Two sinuses in leg, one 8 inches and one 5 inches long	8 ,, ..	1 month ..	,,	—
10	J. W., No. 17724, Grenadier Guards	Cavity in finger after whitlow ..	3 weeks.. ..	8 days ..	,,	—
11	P. V. No. 6503, Suffolks	Cavity and sinus, 2 inches deep in left humerus	14 months ..	3 weeks and 3 days	,,	—

12	George C., No. 712, Royal Fusiliers	Sinus in stump after amputation ..	6 months ..	5 days ..	Cure	—
13	Thomas C., No. 1610, D.L.I.	Wound in shoulder below clavicle, leaving sinus 2½ inches deep	4 ,, ..	16 ,, ..	,,	—
14	Major M., Royal Inniskilling Fusiliers	Sinus in lower end of outside of right humerus 1½ inches deep	10 ,, ..	5 ,, ..	,,	—
15	J. G., No. 2682, Seaforth Highlanders	Ulcer in centre of amputation flap ..	9 ,, ..	3 weeks ..	,,	—
16	Sister N., Q.A.M.N.S.	Large opening at back of right ear following two operations for mastoiditis	7 ,, ..	3 ,, ..	,,	—
17	W. B., No. 10717, Lifeguards	Suppuration of eye socket after enucleation of eyeball	6 ,, ..	3 ,, ..	,,	—
18	Lieut. B., Royal Warwicks	Sinus leading down to right femur, 2 inches deep	7 ,, ..	3 ,, ..	,,	—
19	Lieut. R., Canadian Infantry	Trench gingivitis with ulceration of gums	3 weeks.. ..	3 ,, ..	,,	—
20	W. M., No. 17621, Hants.	Sinus and abscess cavity in amputation stump	6 months ..	5 ,, ..	,,	—
—	—	Total	157 months 2 weeks	18 months 2 weeks	—	—

I have only failed in one case—Major S.-H. He was twice plated for fracture of the femur. The "plate" acted as a "foreign body."

minutes, after which the film can be easily peeled off with a dissecting forceps.

At present our knowledge of the effects of ozone is but small, but, later on, I hope to bring before the medical public some further facts with reference to its working and results, which I feel sure will prove satisfactory.

Correspondence.

PSYCHASTHENIA.

TO THE EDITOR OF THE "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS."

DEAR SIR,—I was greatly struck by the article on Psychasthenia by Colonel Howard Tooth in the Journal of March, 1917, and hope that the attention of every officer may be directed to the subject of that state of unstable mental equilibrium so common at the present time and so liable to be missed on "cursory" examination. Two lines of treatment are meted out, according to the judgment of medical officers:—

(1) Cases are treated as malingerers.

(2) Cases are regarded in a sane and sensible manner and those concerned given a moderate amount of work under supervision and no mental overstrain, i.e., office work and routine.

As one who has seen both lines of treatment meted out—I am thankful to say more often the latter—during the present War, I may be pardoned for intruding my views.

More stress might be laid, in the article, on the evidence of friends and "indications" of confusion of thought shown in letters. The question of relative importance of matters is lost and mental concentration is dissipated and expends itself over trivial details; simple matters become of great moment and food for thought, which no one in ordinary mental health would regard as of any moment at all; hence the fear of responsibility correctly interpreted by the "case." The mind is so apt to be clouded and judgment warped by little details, that the main fact and issue is lost. The individual fears that by his "default" dreadful trouble "officially" may befall him, which, through a wrongful interpretation of his symptoms, may sometimes happen.

More attention should also be directed to the periods of "mental alertness," where the individual concerned may do brilliant work on some details, and then, sooner or later, relapses into his former condition, the aftermath.

At the present time a clear conception and rational treatment of these cases by medical officers may save many a "careful" and nearly always "accurate" worker—"brilliant," perhaps, but erratic—to do useful work for the State in a quiet sphere during the present War.

Military Hospital, Ripon. I am, etc.,

April 13, 1917. WILLIAM LESLIE BENNETT, *Major*, *R.A.M.C.*

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Original Communications.

A NEW METHOD OF PREPARATION OF A VACCINE AGAINST BACILLARY DYSENTERY WHICH ABOLISHES SEVERE LOCAL REACTION. ALSO EXPERIMENTS WITH THIS VACCINE ON ANIMALS AND MAN.

By Captain H. GRAEME GIBSON.
Royal Army Medical Corps.
(*From Vaccine Department, Royal Army Medical College, London*).

CONTENTS.

PART I.

(*a*) Introduction and a Possible Path of Infection with Bacillary Dysentery.

The early appearance of bacillary dysentery among troops in the Near East, and also among the troops of the Central Powers and its later occurrence in France, carries in its train a potential outbreak that might even hold up any offensive that was launched if the disease once obtained a footing.

Inoculation against diseases of the enteric group has removed the danger of these diseases from being a source of anxiety to commanders of armies in the field.

It is quite possible that an effective dysentery vaccine would do the same in the case of that disease also.

Dysentery vaccine in the past has been prohibitive on account of the severe local reaction caused by the subcutaneous inoculation of killed dysentery bacilli, especially those of the Shiga-Kruse type. That this reaction has been overcome will be shown in this paper.

What amount of immunity can be induced by means of a dysentery vaccine consisting of the dead bodies of dysentery bacilli?

The first point to be remembered is that the dysentery bacillus, as a general rule, does not cause the bacillæmia seen in the majority of other diseases for which prophylactic inoculation is employed. The bacillæmia which is on rare occasions seen in the case of *Bacillus dysenteriæ* (Shiga) infection is of course an exception to this rule. On the other hand a prophylactic vaccine against cholera is certainly of use; in this disease we have something approaching the same condition.

The second point to consider is the manner of starting of an infection in the case of bacillary dysentery.

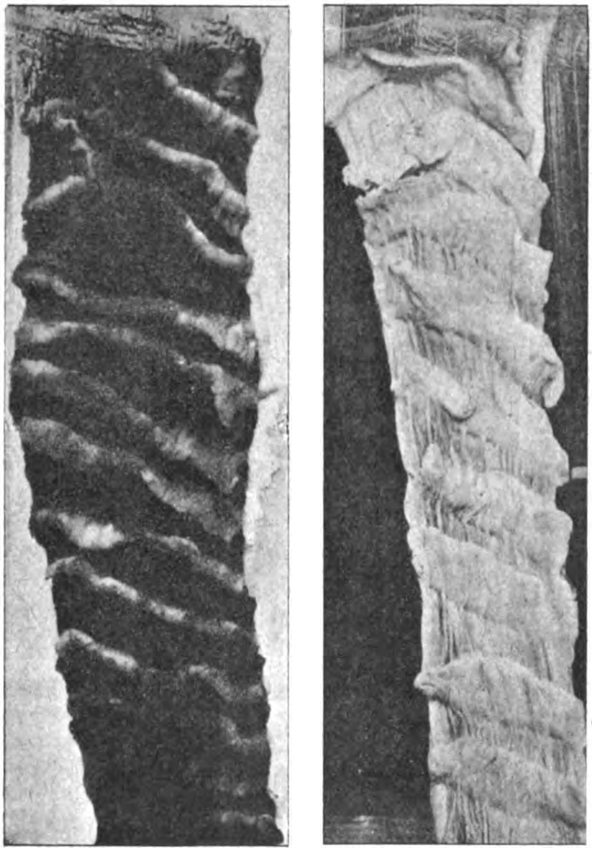
Take for example the laboratory experiment of a rabbit inoculated subcutaneously with a lethal dose of living *B. dysenteriæ* (Shiga).

The animal almost invariably suffers from diarrhœa, unless the dose is so large that it dies of paralysis first, wastes, and sooner or later suffers from paralysis which in most cases is of a paraplegic type affecting the hind quarters.

Post mortem the large bowel is injected, swollen, showing hæmorrhages, and at times even ulceration. The mesenteric glands are enlarged. The spinal cords of rabbits dying from dysentery show chromatolysis of the anterior root ganglia.

Now dysentery toxin when inoculated subcutaneously in rabbits has exactly the same pathological effects (see figs. 1 and 2).

This toxin, or rather endo-toxin, although it has selective action on the mucous membrane of the large bowel and on the nervous system, apparently consists of one part only. Colonel Firth showed



(*a*) (*b*)

FIG. 1.—(*a*) Large intestine of rabbit dying of dose of Shiga toxin, showing œdema and hæmorrhage of gut wall; (*b*) normal large intestine of a rabbit.

that Shiga toxin if emulsified with the mucous membrane of the large bowel and allowed to stand was afterwards harmless to rabbits, not only not causing any gut lesions but the animal did not become paralysed.

Seeing that the dysentery bacilli do not form any appreciable amount of soluble toxin it is extremely improbable, if not impossibe, that the ulceration of the mucous membrane, which is caused by the toxin alone, can be produced by the toxin from the bacilli which are present in the lumen of the gut.

Where else could the bacilli find a lodgement, multiply, and eventually break down setting free their endo-toxin?

In cases of dysentery in man the mesenteric glands are also enlarged post mortem, and from these the dysentery bacilli may be recovered. A possible focus of infection is immediately apparent, the glands becoming infected by invasion of the bacilli via the ducts in the gut wall and lacteals.

The breaking down of the bacilli in the mesenteric glands sets free the toxin, which then acts on the mucous membrane of the large intestine, causing ulcers which when formed afford an additional nidus in which the bacilli can grow.

If this hypothesis as to the mode of infection is true even more should prophylactic inoculation be of some use, for as antibodies when once formed are present in all body fluids the bacilli would be attacked seriatim before they could get the upper hand.

This paper endeavours to show that at least agglutinins and bactericidins are formed in the blood of inoculated individuals, and that their blood has also some anti-toxic properties when injected into rabbits with several lethal doses of toxin. The preliminary experiments in this paper deal only with *B. dysenteriæ* (Shiga) vaccine, as this vaccine being the most toxic is the one that has always caused the most trouble.

(*b*) Preliminary Experiments with Sensitized Vaccine.

These experiments with sensitized vaccines were carried out at the beginning of 1916, and were abandoned owing to the prolonged reaction produced even with small doses.

The vaccine was prepared in the manner given below.

The dysentery (Shiga) bacilli were grown for twenty-four hours on agar. A suspension was then made in normal saline and undiluted anti-dysenteric serum was added to it. This was allowed to remain in contact with it for twenty-four hours at room temperature. The bacilli were then centrifuged down to the bottom of the tube and the serum and saline pipetted off. The bacilli were next washed in normal saline, which was then removed and fresh saline added which contained one per cent carbolic acid.

The suspension was standardized by the opacity method.

Two individuals as well as a number of rabbits were inoculated with this vaccine.

In the case of the two men the first dose was the same in each—0·5 cubic centimetres of the vaccine containing 50 million sensitized *B. dysenteriæ* (Shiga). In the first man the reaction was at first slight, but on the fourth day after inoculation there was considerable tenderness of the arm around the site of inoculation. This was followed by a somewhat indurated swelling that lasted for ten days. A second dose was not given.

In the case of the second man there was again considerable tenderness round the site of inoculation after the first dose. A second dose was given fourteen days after the first.

In this instance the dose was 100 million bacilli divided into two parts of 50 million each. This was injected subcutaneously below both clavicles. This dose did not cause so much tenderness as the first dose, but there was quite a noticeable reaction for about a week. There was no general reaction after any of the inoculations.

Although the reactions were not excessive in either man it was thought that they were too great to warrant the use of vaccine on a large scale in the Army; at the same time it was quite obvious that the dosage could not be increased to any extent, and with the doses given the antibody production was not great as far as laboratory experiments could demonstrate.

I have since heard that the second individual inoculated contracted bacillary dysentery, due to a *B. dysenteriæ* (Shiga) infection two months after inoculation.

(c) Animal Experiments with *B. dysenteriæ* (Shiga) Vaccine mixed with Anti-dysenteric Serum as used for Therapeutic Purposes.

It was then decided to try the effect of giving the vaccine mixed with anti-dysenteric serum with the idea that the anti-endotoxin in the serum would neutralize the endotoxin of the bacilli.

This method has been used in Japan, and from a report of the Tokio Institute the dosage seems to be as follows:—

The first dose is one cubic centimetre of vaccine containing two milligrammes of dysentery bacilli consisting of strains of Shiga, Flexner, and "Y," presumably in equal proportions. An equal part of anti-dysenteric serum is given at the same time,

though whether this is given mixed with the vaccine or given by a separate injection, I have been unable to find out.

The second dose is given four days later; again one cubic centimetre of vaccine is given and mixed with the serum in the proportion of four parts vaccine to one part serum.

The Japanese state that satisfactory results were obtained, but no detailed evidence is produced to this effect nor are any results of experiments as to antibody production published.

In the present experiments the first step taken was to ascertain whether anti-dysenteric serum would prevent the death of a rabbit when inoculated with a dose of vaccine which caused the death of a rabbit when given alone.

The vaccine was prepared in the following way:—

The bacilli were grown on agar for twenty-hours and washed off with normal saline. A sample of the suspension was taken for standardization, which was done by counting in a shallow cell counting chamber by dark-ground illumination.

The remainder of the suspension was killed by the addition of one per cent carbolic acid, and diluted to the required strength with normal saline having a 0·5 per cent carbolic content.

The anti-dysenteric serum used for this experiment was that issued by the Lister Institute for therapeutic purposes.

The first series of rabbits used for experiment is shown in Table I.

No. 1 rabbit was given 500 million bacilli (Shiga) prepared in the way stated above. This was injected subcutaneously into its flank. No serum was given, the rabbit acting as a control.

No. 2 rabbit was given two cubic centimetres of serum into one flank and 500 million bacilli into the other: both were injected at the same time.

No. 3 rabbit was given first two cubic centimetres of serum and 500 million bacilli one hour later, both inoculations being subcutaneous.

No. 4 rabbit was given 500 million bacilli mixed with two cubic centimetres of serum.

No. 5 rabbit was inoculated *intravenously* with 500 million bacilli mixed with two cubic centimetres of serum.

On the following day all the rabbits were well and feeding with the exception of rabbit No. 1 (the control). This rabbit was off its food and suffering from diarrhœa.

It became paralysed in its hind quarters and died on the third day after inoculation. Post mortem there was considerable

inflammation of the tissues round the site of inoculation, and some injection of the gut with enlargement of the mesenteric glands, but otherwise no macroscopic signs of disease.

Microscopic examination of the cord showed the presence of chromatolysis of the anterior root ganglia.

Agglutinins.—The agglutinin content of the sera of the four rabbits was estimated one month later, and in no case could any agglutination be demonstrated.

From this experiment it was seen that the giving of the antiserum with the vaccine neutralized the toxic action of the bacilli, whether it was given separately or mixed with the vaccine. At the same time, owing to the absence of agglutinin in the blood of the animals inoculated the doubt was raised in my mind as to whether the antiserum, besides neutralizing the toxin, had not also neutralized the antigenic properties of the vaccine. As a result of this, it occurred to me that if the anti-bacterial substances in the serum could be removed and the anti-endotoxin left, this difficulty would be overcome.

An attempt to do this by absorption of the serum was carried out as follows :—

(*d*) ANIMAL EXPERIMENTS WITH VACCINE MIXED WITH "ABSORBED" ANTI-DYSENTERIC SERUM, AND A COMPARISON BETWEEN THE AGGLUTININ PRODUCTION IN THIS GROUP OF ANIMALS AND THE GROUP INOCULATED WITH THE WHOLE SERUM.

The serum was absorbed by adding twenty cubic centimetres of the serum to a twenty-four hour culture of *B. dysenteriæ* (Shiga) on agar in a Roux's bottle, and then replacing the mixture in the 37° C. incubator for four hours. It was found that the serum had not been sufficiently treated to fully take out all the agglutinin and so the absorption process was repeated.

After this second time it was found that all the agglutinin had been removed. The serum after absorption was centifuged, but it was impossible to remove all the bacilli by this method. The remaining bacilli can be killed by fractional sterilization at 55° C for half an hour on three consecutive days. (Later, filtration of the absorbed serum was resorted to.)

The following experiment was done to ascertain whether bactericidins had been removed as well as the agglutinins. A fiftieth of a cubic centimetre of diluted serum, complement, and suspension of bacilli were consecutively drawn up in a calibrated capillary tube,

blown out into a sterile watch-glass, and a fiftieth of a cubic centimetre of the mixture again drawn up into the tube. This was placed in the 37° C. incubator for two hours and the whole amount blown out on to an agar plate. This was incubated for twenty-four hours and the number of colonies counted.

The control plate was made by substituting saline for the serum and was plated at once instead of being placed in the incubator.

	Number of colonies	Serum dilution 1—15 colonies	Serum dilution 1—30 colonies	Serum dilution 1—75 colonies
Control plate	45	—	—	—
[1] Whole serum	—	*	2	9
Absorbed serum	—	6	*	67

* = Reading of this dilution not observed.

TABLE I.

No.	Dose and method of inoculation	Date	Result of inoculation	Agglutination titre 4 weeks after	Date of test dose, 5 M.L. doses	Result
1	500 millions Shiga subcutaneously	27.10.16	Died 30.10.16 ..	—	—	—
2	500 millions Shiga + 2 c.c. serum 1 hour previously	27.10.16	No ill effects ..	*Nil*	5.1.17	Died, 8.1.17
3	500 millions Shiga right flank + 2 c.c. serum left	27.10.16	,, ,, ..	,,	5.1.17	Died, 8.1.17
4	500 millions Shiga + 2 c.c. serum left flank	27.10.16	,, ,, ..	,,	5.1.17	Died, 8.1.17
5	500 millions Shiga + 2 c.c. intravenously	27.10.16	,, ,, ..	,,	5.1.17	Died, 8.1.17
6	500 millions Shiga F intravenous	2.11.16	Very sick, diarrhœa, and paralysis; recovered	1—50	5.1.17	Survived
7	500 millions Shiga F + 2 c.c. whole serum intravenous	2.11.16	No ill effects ..	*Nil*	5.1.17	Died, 9.1.17
8	500 millions Shiga F + 2 c.c. absorbed serum intravenous	2.11.16	,, ,, ..	1—50	5.1.17	Died, 9.1.17
9	500 millions sensitized Shiga F intravenous	2.11.16	Sick, diarrhœa; recovered	*Nil*	5.1.17	Died, 10.1.17
10	Control	—	—	—	5.1.17	Died, 8.1.17
11	,, ...	—	—	—	5.1.17	
12	,, ...	—	—	—	5.1.17	
13	,, ...	—	—	—	5.1.17	

The rabbits used in this experiment were Nos. 6, 7, 8 and 9, shown in Table I with the rabbits that had been given vaccine

[1] Throughout this paper "whole serum" refers to anti-dysenteric serum which was used as received from the Lister Institute, and *not* absorbed or treated in any way.

mixed with whole serum. Rabbits Nos. 6, 7, 8 and 9 were inoculated with a vaccine made from a different strain to that used in the previous experiment on rabbits. This strain, a recently isolated one from France, was less toxic than the older strain as evidenced by the failure to kill rabbit No. 6, although this rabbit became very ill and looked as if it would die.

Rabbit No. 6 was given 500 million bacilli with no serum.

Rabbit No. 7 was given 500 million bacilli mixed with two cubic centimetres of the whole serum.

Rabbit No. 8 was given 500 million bacilli mixed with two cubic centimetres of the absorbed serum.

Rabbit No. 9 was given 500 million bacilli which had been used for the first absorption of the serum and so were sensitized. All these rabbits were inoculated intravenously.

Of these rabbits Nos. 6 and 9, No. 6 being the control rabbit and No. 9 the rabbit inoculated with sensitized vaccine, became very ill, refused food and lost weight. They both became paralysed in their hind quarters and suffered from diarrhœa. However, both eventually recovered.

Rabbits 7 and 8 were not affected in any way, both continuing to feed well and put on weight.

Agglutinins.—One month after inoculation the following agglutination titres were observed :—

Rabbit No. 6 (control—no serum)	1—50
,, ,, 7 (whole serum)	*Nil*
,, ,, 8 (absorbed serum)	1—50
,, ,, 9 (sensitized vaccine)	*Nil*

It will be noted that the rabbits inoculated with the vaccine mixed with the absorbed serum gave the same titre as the rabbit that received the vaccine alone, while the rabbits inoculated with the sensitized vaccine and vaccine mixed with the whole serum in both cases were wanting in agglutinin.

All the above estimations of agglutinin content were carried out with a living suspension of bacilli standardized to contain 2,000 million organisms per cubic centimetre. The mixture of diluted serum and emulsion was placed in the 37° C. incubator for four hours and finally read at the end of twenty-four hours. This method was used throughout all the experiments both on rabbits and on man.

All the rabbits Nos. 2 to 9 were given 250 million living *B. dysenteriæ* (Shiga) intravenously on January 5, 1917. That is Nos. 2, 3, 4, and 5 were given about five minimal lethal doses ten

weeks after inoculation with a single dose of vaccine plus whole serum; and Nos. 6, 7, 8 and 9 the same number of minimal lethal doses nine weeks after a single dose of vaccine plus absorbed serum, except in the case of rabbit No. 6, which had had the vaccine alone with no serum, and No. 7 which received the vaccine and whole serum. At the same time four normal rabbits were given 250 million living *B. dysenteriæ* (Shiga).

This was a very severe test and it was not to be expected that much evidence of protection would be forthcoming; however, one of the rabbits survived and it is interesting to note which rabbit this was, namely, No. 6, which had had vaccine alone and had been so ill at the time of inoculation.

(*e*) Inoculation of Rabbits with Two Doses of Vaccine mixed at the Time of Inoculation with "Absorbed" Serum. The Agglutinins produced in their Blood and the Amount of Protection afforded by the Vaccine.

The next series of rabbits were given two inoculations and are shown in Table II.

Nos. 14 and 15 were given 500 million bacilli killed with carbolic as in the case of the previous vaccine. No. 14 was given the vaccine with no serum, and No. 15 was given vaccine which had been mixed with one cubic centimetre of absorbed anti-dysenteric serum. In both cases the inoculation was subcutaneous. Neither rabbit lost weight and both remained well and suffered from no symptoms of toxæmia.

Seven days later they were given a second dose of 1,000 million organisms; No. 15 again having one cubic centimetre of absorbed serum mixed with the vaccine. Both rabbits again remained quite well.

The agglutination titres of these rabbits before and after their inoculations were as follows:—

	Before inoculation	7 days after 1st dose	7 days after 2nd dose
No. 14	*Nil*	1—60	1—200
No. 15	*Nil*	1—100	1—150

From the above it appears that rabbit No. 14 which received no serum with the vaccine was unable at first to form agglutinin as quickly as rabbit No. 15, but in the end its agglutination titre rose to a slightly higher level. The strain used to inoculate these rabbits was the less toxic strain, and on this account the experiment was repeated with a strain of known toxicity, in order to determine whether the absorbed serum would protect against this strain, and

TABLE II.

No.		Date of 1st dose of vaccine	Date of 2nd dose of vaccine	Gain or loss of weight during immunisation	Agglutination titre 7 days after 1st dose	Agglutination titre 7 days after 2nd dose	Date of giving test doses of living *B. dysenteriæ* Shiga	Result
14	..	500^6 Shiga (F) 20.12.16	$1{,}000^6$ Shiga (F) 27.12.16	+ 250 grammes	1—60	1—200	250^6 living Shiga (L) 28.1.17	No ill effects. The test dose was given one month after inoculation.
15	..	500^6 Shiga (F) + 1 c.c. absorbed serum, 20.12.16	$1{,}000^6$ Shiga (F) + 1 c.c. absorbed serum, 27.12.16	− 100 ,,	1—100	1—150	250^6 living Shiga (L) 28.1.17	No ill effects. The test dose was given one month after inoculation.
15 (a)	Control to 14 and 15	—	—	—	—	—	250^6 living Shiga (L) 28.1.17	This dose caused loss of one-fifth of the rabbit's weight, it was sick on the third day and became paralysed on the fourth, but eventually recovered.
16	Control to 17	500^6 Shiga (L) 4.1.17	—	—	—	—	—	Died 8.1.17.
17	..	500^6 Shiga (L) + 1 c.c. absorbed serum, 4.1.17	$1{,}000^6$ Shiga (L) + 0·75 c.c. absorbed serum, 11.1.17	+ 150 grammes	*	1—150	250^6 living Shiga (L) 9.2.17	Died on the fourth day after test dose, which was given one month after inoculation. At the time of the test dose the rabbit's blood failed to agglutinate *B. dysenteriæ* Shiga.
17 (a)	Control to 17	—	—	—	—	—	100^6 living Shiga (L) 9.2.17	Died on the fifth day.
18	Control to 19	500^6 Shiga (L) 22.1.17	—	—	—	—	—	Died 25.1.17.
19	..	500^6 Shiga (L) + 0·5 c.c. absorbed serum, 22.1.17	$1{,}000^6$ Shiga (L) 1.2.17	− 50 grammes	*	1—500	200^6 living Shiga (L) 15.2.17	Survived this dose which was given fourteen days after inoculation; the rabbit was partially paralysed for one day.
19 (a)	Control to 19	—	—	—	—	—	200^6 living Shiga (L) 15.2.17	Died on the fourth day.
20	Control to 21	500^6 Shiga (L) 29.1.17	—	—	—	—	—	Died 2.2.17.
21	..	500^5 Shiga (L) + 0·5 c.c. absorbed serum, 29.1.17	$1{,}000^6$ Shiga (L) + 0·25 c.c. absorbed serum, 6.2.17	+ 100 grammes	—	1—150	250^6 living Shiga (L) 28.2.17	Died on the second day; no paralysis, no lesions of bowel; the right lung showed the presence of bronchopneumonia.
21 (a)	Control to 21	—	—	—	—	—	250^6 living Shiga (L)	Died on the fourth day, showing the usual lesions; post-mortem.

Note.—500^6, $1{,}000^6$, &c. = 500 million, 1,000 million, &c.

also to determine whether the use of a more toxic strain resulted in the production of more agglutinin in the rabbit's blood.

Rabbits Nos. 16 and 17 were given a vaccine made in the same way as the last, but containing 500 million bacilli of the toxic strain L.

Rabbit No. 16 was given no serum with the vaccine, while No. 17 was given the vaccine plus one cubic centimetre of absorbed serum. Rabbit No. 16 died on the fourth day after inoculation with the usual post-mortem appearances. Rabbit No. 17 continued well and lost no weight.

From the above experiments it is evident that the addition of anti-dysenteric serum to the vaccine neutralizes the toxic effects of the *B. dysenteriæ* (Shiga) bacillus; also that the removal of the anti-bacterial substances from the serum does not interfere with its antitoxic action. At the same time the removal of the sensitizing substance results in the formation of agglutinins in the blood which cannot be demonstrated when whole serum is used.

Rabbit No. 17 was given a second dose of the vaccine (1,000 million) mixed with 0·75 cubic centimetres absorbed serum eight days after the first dose. This dose also produced no symptoms in the rabbit, which remained quite well, and lost no weight.

The following agglutinin estimations were carried out in order to determine whether the more toxic strain produced a greater amount of agglutinin in the blood.

	Titre prior to inoculation	Titre 7 days after the 2nd dose
Rabbit No. 17 ..	*Nil* ..	1—150

In this instance the agglutinin production was no higher when a more toxic strain was used than in the case of rabbit No. 15, which was inoculated with the less toxic strain F.

In the next experiment the second dose of vaccine was given without any serum. This did not do any harm to the rabbit and a much higher agglutination was the result. It was afterwards tried in man, but without the same success as an indurated mass at the site of inoculation was the result, which lasted for about ten days.

Rabbits No. 18 and 19 were each given 500 million bacilli of the strain L, No. 19 receiving 0·5 cubic centimetres of absorbed serum mixed with the vaccine. No. 18 was given the vaccine with no serum. The serum used in this experiment was filtered after being absorbed, so that the experiment was also used to determine whether the filtering affected the antitoxic properties of the serum.

No. 18 died, while No. 19 showed no ill effects.

Ten days after the first dose No. 19 was given a second dose of the same vaccine (1,000 million bacilli) without any serum. The rabbit remained well but lost fifty grammes in weight. Two more rabbits were inoculated with the same strain of Shiga, and in this case less serum was given with the vaccine.

No. 20 was given 500 million bacilli without any serum, and No. 21 was given 500 million bacilli mixed with 0·5 cubic centimetre absorbed and filtered serum. Rabbit No. 20 died on the fourth day after inoculation, while No. 21 was not affected.

On the eighth day after the first dose rabbit No. 21 was given a second dose of 1,000 million bacilli mixed with 0·25 cubic centimetre of absorbed and filtered serum. The rabbit suffered in no way from the second dose.

The following agglutination titres were given by rabbits 19 and 21 seven days after their second doses :—

Rabbit No. 19	1—500
,, ,, 21	1—150

Rabbits Nos. 14, 15, 17 and 21 were then tested against living *B. dysenteriæ* (Shiga) injected at varying periods after the second inoculation. The strain of Shiga used was the toxic strain L, of which the minimal lethal dose is about 50 million bacilli.

Table II shows the result of these doses.

Rabbit No. 19 was given 200 million living *B. dysenteriæ* (Shiga) subcutaneously fourteen days after the second dose of vaccine, and was controlled by the rabbit No. 19 (*a*) which received the same dose of living bacilli. This dose represented about four minimal lethal doses.

Rabbit No. 19 was partially paralysed for one day but recovered and lost no weight. The control rabbit died on the 4th day. Figs. 2 and 3 show the large intestines of these two rabbits, fig. 2 being that of the control rabbit showing the hæmorrhagic condition of the intestinal wall with commencing ulceration : fig. 3 shows the large intestine of rabbit No. 19, which was killed eight days after the test dose with a normal gut. At the time of the test dose the agglutination titre of rabbit No. 19 for *B. dysenteriæ* (Shiga) was 1 in 200.

One cubic centimetre of the serum of this rabbit (No. 19) was mixed with a test dose, 0·25 milligramme of dried toxin, of which 0·05 milligramme killed three control rabbits within seventy-two hours, and injected into a second rabbit. Although it did not save the rabbit it enabled it to survive until the sixth day after the test dose was given. Rabbit No. 21 was given about five minimal lethal

doses of living Shiga three weeks after its second dose of vaccine. This rabbit was found dead in its cage on the morning of the second day after the test dose. As this rabbit was not paralysed and post mortem presented none of the usual signs seen in rabbits dying of

FIG. 2. FIG. 3.

FIG. 2.—The large intestine of a rabbit which died after subcutaneous inoculation of 250 million *B. dysenteriæ* (Shiga), living; showing œdema, hæmorrhages, and ulceration of gut wall.

FIG. 3.—The large intestine of an *inoculated* rabbit which was given the same dose as the rabbit from which the gut shown in fig. 2 was removed. This rabbit was killed eight days after the test dose.

dysentery toxin, while its right lung was collapsed, and this on section showed the presence of broncho-pneumonia, this cannot be put down as a failure to protect.

Rabbit No. 17 was given five minimal lethal doses one month after inoculation. In this case the vaccine failed to protect the rabbit. It died on the fourth day, while the control rabbit which had only received two minimal lethal doses died on the fifth day. At the time of giving rabbit No. 17 its test dose its blood failed to agglutinate *B. dysenteriæ* (Shiga) in a dilution of 1 in 10.

Rabbits Nos. 14 and 15 were both given five minimal lethal doses intravenously one month after inoculation. Both remained perfectly well. Unfortunately the control rabbit 15 (*a*) shook its head free while the test dose was being given intravenously, and the exact dose given was not certain. However, it became paralysed on the third day, and lost one-fifth of its body weight. It eventually recovered. Table II also shows the controls to the rabbits at the time of inoculation.

From these experiments on rabbits it is quite certain that a Shiga vaccine can be given when mixed with absorbed serum with perfect safety. Also a second dose can be given without serum and good agglutinins produced in the blood of the animal.

As tested with lethal doses of living bacilli there appears to be some protection by inoculation, although this is not absolute, which is not to be expected with any vaccine.

The protection in the case of the rabbit is of course an antitoxic protection.

Another point brought out is that although a rabbit's blood will not give absolute protection to a second animal, yet the rabbit may be itself protected.

PART II.

Preliminary Experiments on Man.

After the first experiments on rabbits with the vaccine mixed with the absorbed serum I was satisfied that the vaccine could by this means be given to man without any fear of a severe local reaction such as has been seen in the past with untreated or sensitized vaccines.

In these experiments also the antibody production in the blood of men inoculated with the vaccine mixed with the whole serum and in those inoculated with the vaccine mixed with the absorbed serum was compared, as from the animal experiments the impression given was distinctly that the vaccine mixed with the absorbed serum was superior in its antigenic properties to the same vaccine when mixed with the whole serum.

The vaccine used was prepared in the same way as that used for the rabbits, and standardized to contain 2,000 million organisms to the cubic centimetre in order to reduce the bulk of fluid in each dose when mixed with the serum.

The first individual inoculated, H. G., received a first dose consisting of 0·25 cubic centimetre of the vaccine (500 million bacilli) mixed with one cubic centimetre of the Lister Institute anti-dysenteric serum. In this instance the *whole* serum was used.

The inoculation was given subcutaneously into the left arm at the level of the insertion of the deltoid. This dose produced no general reaction and practically no local symptoms. On the same evening as the inoculation, about six hours later, a localized urticaria appeared over the upper arm.

On the following day there was a certain amount of œdema spreading down the arm but no tenderness or pain, and the reaction was in no way sufficient to prevent any manual labour being undertaken. This œdema took about three days to subside and small patches of urticaria recurred from time to time.

Eight days after this first dose no antibodies could be demonstrated in the blood either in the way of agglutinins, bactericidins, or complement fixing antibodies.

On this day a second dose was given. This consisted of 0·5 cubic centimetre of the vaccine (1,000 million organisms) with 1 cubic centimetre of the *whole* serum, making the total bulk up to 1·5 cubic centimetres.

Two and half hours later there was distinct tenderness over the upper arm, and six hours after the inoculation there was some throbbing and œdema present. No urticaria developed after the second dose. On the following day there was a gradually increasing œdema, but the tenderness and pain had practically gone, though the arm was still stiff enough to prevent any violent exercise being taken. The œdema increased throughout the day and on the following morning (third day) was very marked, extending almost to the wrist. There was no pain and only very slight tenderness and the arm could be freely moved. By the fourth day all œdema had disappeared, the only sign of reaction remaining being a slight thickening at the site of inoculation.

Ten days after the second dose five cubic centimetres of blood were drawn off from the median basilic vein. This blood was allowed to clot and 2·5 cubic centimetres of serum were obtained.

The results of the examination of this serum are shown with those of the serum obtained from Pte. H., which is the case next

described which shows the result of inoculation with the vaccine mixed with *absorbed* serum (see also Part IV, Experiment 4).

Pte. H. was given as a first dose 0·25 cubic centimetre of the vaccine (500 million organisms) mixed with one cubic centimetre of *absorbed* Lister Institute serum which had been absorbed in the same way as that used in the rabbit experiments.

He stated that he had some shivering and malaise at about 10.30 p.m. on the evening of the day on which he was inoculated. On the following morning he had some slight diarrhœa but otherwise felt quite well. There was tenderness round the site of inoculation with some slight œdema and a considerable flush. The local reaction resembled that seen after anti-typhoid inoculation very much indeed. The arm was normal again on the morning of the third day. On the seventh day after the first dose his blood was taken for an estimation of the agglutinin content, and he received a second dose consisting of 0·25 cubic centimetre of the vaccine (500 million) mixed with 0·75 cubic centimetre of *absorbed* serum. The dose of vaccine was kept the same as in the first dose as the serum was reduced in amount. The reaction was less marked than after the first dose, but there was again slight diarrhœa on the morning following the inoculation. The local reaction had practically passed away in twenty-four hours. The lessened reaction after the second dose points to the establishment of a certain amount of immunity after the first dose.

Ten days later five cubic centimetres of blood were drawn off from his median basilic vein, from which were obtained two cubic centimetres of serum.

The following tests were carried out with the sera from these two men:—

(1) Agglutination tests.
(2) Estimation of bactericidins.
(3) Antitoxic content of the blood.

TABLE III.—AGGLUTINATION TITRES.

	Before inoculation	7 days after 1st dose	10 days after 2nd dose	1 month after 2nd dose
H. G.	*Nil*	*Nil*	*Nil*	*
Pte. H.	*Nil*	1—50	1—100	1—100

* = Serum not tested at this date.

ESTIMATION OF BACTERICIDIN CONTENT.

	Colonies on control plate	Serum 1—15	Serum 1—75	Serum 1—125	Serum 1—300
H. G.	250	254	248	203	298
Pte. H.	45	3	19	19	*

* = This dilution was not tested.

EXPERIMENT ON THE ANTITOXIC PROPERTIES OF THE SERUM.

These experiments were carried out for me by Dr. R. A. O'Brien at Brockwell Hall laboratories. The serum was sent to him on the day after it was drawn off. The serum and dried dysentery (Shiga) toxin was mixed in varying quantities and inoculated intravenously into rabbits.

Two control rabbits were inoculated with 0·25 and 0·1 milligramme respectively. They both died in two days.

TABLE IV.

	Dose of toxin	Amount of serum	Result
1. Control	0·25 mgm.	*Nil*	Rabbit died 2nd day
2. Control	0·1 ,,	*Nil*	Rabbit died 2nd day
3. H. G. serum. 10 days after inoculation	0·25 ,,	0·5 c.cm.	Rabbit died 2nd day
4. H. G. serum. 10 days after inoculation	0·25 ,,	1·5 ,,	Rabbit died 3rd day
5. Pte. H. serum. 10 days after inoculation	0·25 ,,	0·5 ,,	Rabbit survived
6. Pte. H. serum. 10 days after inoculation	1·0 ,,	0·1 ,,	Rabbit died 3rd day
7. Pte. H. serum. 10 days after inoculation	* 0·25 ,,	0·5 ,,	Rabbit died 5th day
8. Pte. H. serum. Drawn 1 month after inoculation	0·25 ,,	0·5 ,,	Rabbit survived

* = The serum used for this retest was kept three weeks after being drawn off before it was used for the test.

From these series of experiments it will be seen that the blood of the man inoculated with the vaccine and *whole* serum was lacking in agglutinin, bactericidins, and antitoxic properties, while the blood of the man inoculated with the vaccine mixed with the absorbed serum had all these properties.

The serum of three normal men (one cubic centimetre) also failed to protect rabbits against 0·25 milligramme of dried toxin. Following on these, two experiments were undertaken to note the effect of increasing the second dose of the vaccine with a smaller amount of serum mixed with it both as regards the reaction and antibody formation.

Pte. Hg. was given 500 million Shiga mixed with one cubic centimetre *absorbed* serum. No general reaction followed this inoculation until the next day, when he complained of headache and "aching of the lower part of the body." The headache was still present to a lesser degree on the second day after inoculation, but passed off during the day. The local reaction was not severe. On the morning after the injection the arm was swollen and stiff, and on the second day there was some slight œdema with a certain

amount of pain and tenderness. This had passed off on the morning of the third day. The man was not prevented from continuing his work. Seven days later he was given a second dose, consisting of 1,000 million bacilli mixed with 0·5 cubic centimetre *absorbed* serum. He stated that on the same night as the inoculation he suffered from headache. This had gone off by the following morning. The local reaction was rather more prolonged than after the first dose. On the next morning there was some œdema and irritation. The stiffness and tenderness lasted for four days, during which time he stated that he could not lift any heavy weights. There was no general reaction to be seen after the third day.

Pte. B.—This man was given as a first dose 500 million bacilli, mixed with 0·75 cubic centimetre *absorbed* serum.

The general reaction came on the same evening. He stated that he was going out of barracks, but "felt seedy," and so returned and went to bed suffering from headache and a feeling of malaise. All this had passed off by the following morning. The local reaction consisted of some swelling and a patch of inflammation round the site of the injection. This had practically disappeared at the end of the second day.

A second dose of 1,000 million bacilli was given without any serum. There was no general or local reaction until the second day. On this day there was some slight diarrhœa. The local reaction on this day became marked. Inflammation was present, spreading down to the elbow-joint, in which the man states there was a considerable amount of pain. A hard indurated mass slowly developed round the site of inoculation. This hard mass, with inflammation, pain, and tenderness, persisted for more than a week. The strain of *B. dysenteriæ* (Shiga) used was the less toxic strain F.

This dose was given in order that the effect of the vaccine used without serum for the second dose might be noted. From the result obtained, the method may be dismissed at once.

The agglutinin production of these two men was as follows :—

	Before inoculation	After 1st dose	10 days after 2nd dose	1 month after 2nd dose
Pte. Hg.	*Nil*	1—20	1—50	1—50
Pte. B.	*Nil*	1—20	1—75	1—20

In both cases these two men gave a lower agglutinin content than did Pte. H., and it seems probable from this that if the vaccine could be given alone without serum the titre for *B. dysenteriæ* (Shiga) would not be raised as Pte. B.'s second dose was given without serum.

It was thought that Pte. Hg.'s reaction was due to the serum rather than to the toxin of the vaccine, and so the same dose of vaccine was given to another man, Pte. G., and only 0·5 cubic centimetre of absorbed serum was mixed with each dose.

The first dose consisted of 500 million bacilli mixed with 0·5 cubic centimetre *absorbed* serum.

There was no general reaction. On the following morning there was a flush over the upper arm round the site of inoculation accompanied by some slight tenderness. This had all disappeared in forty-eight hours. There was no incapacity for work.

The second dose was given on the seventh day, and consisted of 1,000 million bacilli mixed with 0·5 cubic centimetre *absorbed* serum.

There again was no general reaction. No diarrhœa was experienced after either dose of vaccine. On the day following the second dose there was again a slight flush over the upper arm, and the man stated that there was some slight pain round the elbow joint. He said that he felt the second inoculation less than he did the first. There was no serum disease noticeable in the case of this man.

Agglutination Titre of the Serum.

Before inoculation		7 days after 1st dose		10 days after 2nd dose		5 weeks after 2nd dose
Nil	..	1—50	..	1—150	..	1—100

The next experiment on man was carried out to determine whether the efficiency of the serum was interfered with by filtering the serum after absorption.

Pte. L. was given 500 million bacilli mixed with 0·5 cubic centimetre *absorbed and filtered* as a first dose.

He stated that he was slightly restless during the night after he was inoculated. There were no other constitutional symptoms. The local reaction on the day following the dose of vaccine consisted of a flush over the upper arm with slight tenderness. At the end of forty-eight hours this had practically disappeared.

Seven days later a second dose of 500 million bacilli was given mixed with 0·25 cubic centimetre *absorbed and filtered* serum. This was followed by no general reaction and by a very slight local reaction, which was less than that experienced after the first dose. This had disappeared in forty-eight hours.

The agglutination titre estimated ten days after the second dose was 1 in 100.

PART III.

EXPERIMENTS WITH VARIOUS VACCINES ON NINETY-SEVEN MEN AT THE ROYAL ARMY MEDICAL CORPS DEPOT, ALDERSHOT.

(*a*) *The Constitution of the Various Vaccines employed.*

These experiments were carried out with various dysentery vaccines in order to observe the reaction produced and the amount of agglutinin formed in the blood of the inoculated men. In all ninety-seven men were inoculated and were divided into seven main groups. The vaccines used were those prepared by killing the *B. dysenteriæ* (Shiga) with eusol, as proposed by H. R. Dean[1] and advocated by the Medical Research Committee in their report for 1916, and vaccines prepared by mixing absorbed serum with a saline emulsion of the dysentery bacilli either at the time of inoculation or at the time of preparation of the vaccine.

Groups A, B, and C were inoculated with the eusol killed vaccine, and Groups D, E, F, and G, were inoculated with the sero-vaccine; Group G acted as a control group to E and F, as the serum given with the vaccine in Group G was serum which had not been absorbed. Group D was put into the experiments, as the men in this group were inoculated against *B. dysenteriæ* (Shiga) only, and so correspond with the groups inoculated with the eusol killed vaccine; while men in Groups E, F, and G were inoculated with Shiga, Flexner, and "Y" strains.

The groups were constituted as follows:—

Group A.—This group consisted of twenty men, each of whom received 500 million *B. dysenteriæ* (Shiga), which had been killed by eusol of a strength of 1 in 10. For the second dose the number of bacilli was doubled, i.e., they received 1,000 million. The bulk of vaccine contained in the first dose was 0·25 cubic centimetre, and in the second 0·5 cubic centimetre.

This vaccine had been prepared fifteen days before use. (It will be seen later that this is a most important point).

Group B.—Ten men were included in this group, and each man was given 500 million *B. shiga*, prepared in the same way, with the exception that the bacilli were killed by eusol of a strength of 1 in 20. The vaccine was again in this case fifteen days old when used. A second dose was not given owing to the severe local reaction experienced with this vaccine.

Group C.—Ten men were again included in this group. The

[1] "A Preliminary Note on a Method of Preparation of a Non-toxic Dysentery Vaccine," H. R. Dean and R. S. Adamson, *Brit. Med. Journ.*, vol. i, 1916, p. 611.

vaccine used was the same in every respect as that used in Group A, the same dose being given, with the exception that the vaccine was *sixteen weeks old* instead of fifteen days. In the case of this vaccine also the severity of the local reaction produced precluded a second dose being given.

(In all the above vaccines the eusol remains as part and parcel of the vaccine.)

Group D.—This group consisted of seven men only and the vaccine used was the same as that used in the preliminary experiments, i.e., it consisted of *B. dysenteriæ* (Shiga) only, which was mixed at the time of inoculation with 0·5 cubic centimetre of absorbed and filtered serum. This vaccine was eight weeks old when used.

The first dose given was 500 million bacilli and the second 1,000 million.

Group E.—This group was subdivided into two further groups. Both sub-groups were given the same first dose consisting of 500 million *B. dysenteriæ* (Shiga), 250 million *B. dysenteriæ* (Flexner), and *B. dysenteriæ* "Y". This saline suspension was mixed at the time of preparation with 0·5 cubic centimetre of absorbed and filtered serum. The vaccine was ten days old when used. Sub-group E1 consisted of fifteen men; each of whom received a second dose of double the above amounts mixed with 0·5 cubic centimetre absorbed and filtered serum which again had been mixed with the vaccine at the time of preparation. Sub-group E2 received as a second dose the same amount as that contained in the first dose. Ten men men were included in this sub-group.

Group F.—This group was also subdivided into groups F1 and F2. All the men in both sub-divisions received the same first dose which was the same as that used in Group E, except that the serum instead of being mixed with the vaccine at the time of preparation was mixed at the time of inoculation. The vaccine was ten days old at the time of use.

Sub-group F1 consisted of fifteen men who received as their second dose 1,000 million *B. dysenteriæ* (Shiga), 500 million *B. dysenteriæ* (Flexner), and 500 million *B. dysenteriæ* "Y" mixed with 0·5 cubic centimetre of serum.

Sub-group F2 consisted of five men who received as their second dose the same amount of vaccine as they were given as a first dose again mixed with 0·5 cubic centimetre of serum.

Group G.—This group consisted of ten men who received as their first dose the same vaccine, and in the same amount as the men of the previous group, but instead of the serum which was mixed with it being absorbed 0·5 cubic centimetre of whole serum

was mixed with it at the time of inoculation. The second dose was double the first mixed with 0·5 cubic centimetre whole serum.

This vaccine was also ten days old when used.

(*b*) *The Reactions noted after the First Dose.*

A general reaction was noted in well over fifty per cent of all the men inoculated, though this ratio varied to some extent with the type of vaccine used.

Headache of varying degree was the predominant symptom either alone or combined with other symptoms. Diarrhœa was present as a symptom in three men inoculated with the vaccine used in Group A. In one of these men the diarrhœa came on the first day after inoculation, and in two men the second day after. In each case this symptom lasted until the fourth day. Diarrhœa was not noticed with men in any other group.

The inoculation was done in the morning in order that the general reaction might be brought out as much as possible, as when men are inoculated at the best time for the operation, i.e., in the evening, a great part of the general reaction is lost sight of during sleep. In only one instance was any rise of temperature noted, in the case of a man in Group E. This man was admitted to hospital on the following day suffering from a relapse of "trench nephritis," from which he had suffered in France in November of last year, that is, three months previously.

The general reaction was for the most part over by the following morning or disappeared during the day after inoculation. The symptoms noted are tabulated under the heading of the groups, and are shown in percentages as well as in actual numbers.

Group A.				
(*a*) No general reaction	6	=	30	per cent
(*b*) Headache alone	9	=	45	,,
(*c*) Headache and malaise	1	=	5	,,
(*d*) Headache and abdominal pain	1	=	5	,,
(*e*) Abdominal pain alone	2	=	10	,,
(*f*) "General pains"	1	=	5	,,
Group B.				
(*a*) No general reaction	5	=	50	per cent
(*b*) Headache alone	1	=	10	,,
(*c*) Headache and dizziness	1	=	10	,,
(*d*) Nausea with inclination to vomit ..	3	=	30	,,
Group C.				
(*a*) No general reaction	4	=	40	per cent
(*b*) Headache alone	—		—	
(*c*) Headache and dizziness	1	=	10	per cent
(*d*) Headache with pain in back	1	=	10	,,
(*e*) Malaise alone	1	=	10	,,
(*f*) Frequent micturition	1	=	10	,,
(*g*) Nausea with inclination to vomit ..	2	=	20	,,

Group D.

(a)	No general reaction	4	=	57 per cent
(b)	Headache alone	1	=	14·3 ,,
(c)	Nausea with inclination to vomit ..	1	=	14.3 ,,
(d)	Slight abdominal pain	1	=	14·3 ,,

Group E.

(a)	No general reaction	3	=	15 per cent
(b)	Headache alone	14	=	70 ,,
(c)	Headache and nausea	1	=	5 ,,
(d)	Malaise alone	1	=	5 ,,
*(e)	Temperature and pain in back	1		—

Group F.

(a)	No general reaction	3	=	15 per cent
(b)	Headache alone	11	=	55 ,,
(c)	Malaise alone..	6	=	30 ,,

* Admitted to hospital with a relapse of "trench nephritis."

The headaches present as a symptom of the general reaction were for the most part slight and had disappeared by the following morning. This general reaction in my opinion is less than that seen after T.A.B. inoculation, and would probably have been less marked still if the inoculation had been carried out in the afternoon.

Local Reactions.—In no case was there a really marked local reaction to be seen at the end of twenty-four hours. The reactions that became marked did so at a later period.

The course of the local reactions can best be shown under the various groups, and tables showing the state on successive days after inoculation are given below.

On the first day after inoculation the reactions are divided into: (*a*) No local reaction; (*b*) very slight local reaction; (*c*) slight local reaction; (*d*) mild local reaction, and (*e*) moderate. These terms are only used to differentiate between the various groups.

TABLE V.—LOCAL REACTIONS ON THE FOLLOWING DAY.

	No local	Very slight	Slight	Mild	Moderate
Group A	—	25	40	15	20
,, B	—	20	10	30	40
,, C	—	30	10	30	30
,, D	14·3	43	28	14·3	—
,, E	—	15	20	55	10
,, F	—	65	—	35	—
,, G	10	80	10	—	—

The figures in the above table represent percentages.

TABLE VI.—LOCAL REACTIONS AT THE END OF FORTY-EIGHT HOURS.

	Local reaction gone	Fit for duty. Local reaction not quite gone	Not fit for duty	Reaction greater than after 24 hours
Group A ..	45 per cent	25 per cent	30 per cent	5 per cent
,, B ..	20 ,,	10 ,,	70 ,,	50 ,,
,, C ..	10 ,,	10 ,,	80 ,,	60 ,,
,, D ..	50 ,,	33·8 ,,	16·6 ,,	—
,, E ..	20 ,,	60 ,,	15 ,,	—
,, F ..	40 ,,	45 ,,	15 ,,	—
,, G ..	70 ,,	30 ,,	—	—

TABLE VII.—LOCAL REACTIONS AT THE END OF SEVENTY-TWO HOURS.

	Back at duty	Local reaction gone	Not gone, but fit for duty	Not fit for duty	Increased reaction	Very severe reaction
Group A	—	75 per cent	25 per cent	—	—	—
,, B	—	30 ,,	—	70 per cent	70 per cent	—
,, C	—	10 ,,	20 per cent	70 ,,	50 ,,	—
,, D	100 per cent	—	—	—	—	—
,, E	100 ,,	—	—	—	—	—
,, F	All at duty except one man with slight serum reaction.					
,, G	100 per cent	—	—	—	—	—
	LOCAL REACTIONS AT THE END OF NINETY-SIX HOURS.					
Group A	80 per cent	15 per cent	—	5 per cent	5 per cent	—
,, B	30 ,,	30 ,,	—	70 ,,	—	70 per cent
,, C	20 ,,	20 ,,	—	60 ,,	—	80 ,,
,, D	100 ,,	—	—	—	—	—
,, E	100 ,,	—	—	—	—	—
,, F	100 ,,	—	—	—	—	—
,, G	100 ,,	—	—	—	—	—

At the end of the fifth day all the men in Group A had returned to duty, while all the men in Groups B and C had very severe reactions. These reactions were still very severe on the seventh day after inoculation, so much so that it was out of the question to give a second dose.

The medical officer in charge of the Depot wrote as follows of the men in groups B and C on the fourth day after inoculation:—

"All these men, even in those cases where local reaction is not severe, complain of intense local pain at the inoculation site; many of them state that they have had very little sleep since inoculation. Pressure, such as the weight of a blanket, unbearable. The redness in every case is confined to two or three inches round the site of the

inoculation, while the swelling has a well defined margin about the lower third of the forearm. In one or two cases the axillary glands were swollen and painful."

When I saw these men on the seventh day after inoculation the œdema had spread down to the hand in many cases and they were still complaining of a great deal of pain.

In the case of the men in Group A and in the groups in which serum was given with the vaccine the reaction was much less, in fact in every case mild and less marked than that met with after T.A.B. vaccine. The men who received serum with the vaccine had even less reaction than those in Group A.

Now the vaccine used in Group A was the same in every respect as that used in Group C, except that the vaccine used in Group C was sixteen weeks old, while in Group A it was only fifteen days old.

It is known that eusol does not keep its properties, and it appears that the toxin that is set free by the breaking down of the bacilli in the vaccine after some time cannot be neutralized on this account, although if the vaccine is used quite fresh the eusol being still active is able to achieve this. This fact seems to be a source of danger and one that would be sure to lead to trouble if the vaccine was used in the service on a large scale.

Another interesting point that was brought to light in these experiments is that the absorbed aud filtered serum does not produce anything like the same amount of local serum disease in the form of urticaria as does the untreated serum.

(c) *The Reactions Noted after the Second Dose.*

These doses were given seven days after the first dose.

It has already been stated that the second dose could not be given to men in groups B and C.

The general reaction after the second dose was very much less marked than after the first. Headache, where present, was usually only of a slight degree.

Table VIII shows the reactions noted in the various groups :—

It will be observed that the number of men in whom no general reaction was present was greater than after the first dose of vaccine. In Group D the percentage of "no reactions" is low, but this group only consisted of seven men, and the men who suffered from headache or malaise all said that it was very slight.

TABLE VIII.—GENERAL REACTION ON THE DAY AFTER INOCULATION.

	No general reaction	Headache	Headache and pain in back	Headache and temperature	Malaise	Diarrhœa
Group A	60 per cent	25 per cent	5 per cent	—	5 per cent	5 per cent
,, D	14·3 ,,	42·8 ,,	—	—	42·8 ,,	—
,, E1	50 ,,	35·7 ,,	—	14·3 per cent	—	—
,, E2	60 ,,	40 ,,	—	—	—	—
,, F1	86 ,,	13·3 ,,	—	—	—	—
,, F2	80 ,,	20 ,,	—	—	—	—
,, G	90 ,,	10 ,,	—	—	—	—

Local Reaction.—Taken all round this was also less than after the first dose, except in the case of men in Group E1, who received 1,000 million *B. dysenteriæ* (Shiga), 500 million *B. dysenteriæ* (Flexner), and 500 million *B. dysenteriæ* "Y," with 0·5 cubic centimetre of absorbed and filtered serum which had been mixed with the vaccine at the time of preparation. In these men the reaction was slightly more marked than after the first dose, at the end of twenty-four hours.

TABLE IX.—LOCAL REACTIONS AT THE END OF TWENTY-FOUR HOURS.

	Very slight local reaction	Slight local reaction	Mild local reaction	Moderate local reaction
Group A ..	45 per cent	25 per cent	25 per cent	5 per cent
,, D ..	42·8 ,,	42·8 ,,	14·3 ,,	—
,, E1 ..	—	7·1 ,,	77·4 ,,	21·4 ,,
,, E2 ..	60 ,,	40 ,,	—	—
,, F1 ..	46·6 ,,	26·6 ,,	26·6 ,,	—
,, F2 ..	80 ,,	20 ,,	—	—
,, G ..	40 ,,	50 ,,	10 ,,	—

TABLE X.—DAYS ON WHICH THE MEN WERE FIT FOR DUTY AFTER THE SECOND DOSE.

	Second day	Third day	Fourth day	Fifth day	Ninth day	Indurated mass still painful ninth day	Abscess formed
Group A	15 per cent	25 per cent	20 per cent	—	5 per cent	30 per cent	5 per cent
,, D	28·5 ,,	42·8 ,,	28·5 ,,	—	—	—	—
,, E1	21·4 ,,	35·7 ,,	35·7 ,,	7·1 per cent	—	—	—
,, E2	60 ,,	40 ,,	—	—	—	—	—
,, F1	40 ,,	46·6 ,,	13·3 ,,	—	—	—	—
,, F2	80 ,,	20 ,,	—	—	—	—	—

In Group G a reasonable ratio of the days on which the men were fit for duty could not be arrived at, as about half the men were absent on the day that I went to see them.

The principal feature in the men that I saw was the increased serum reaction when compared with the men that were given absorbed and filtered serum with the vaccine. The men in this group suffered very badly with urticaria which persisted on the average about four or five days. The men in Group A who still had indurated and painful masses in the arms on the ninth day after inoculation stated that these began to appear on the fifth or sixth day after the injection. The "five per cent abscess" represents one man only among the twenty inoculated with this vaccine. The mass in his arm had a "boggy" feeling and was obviously going to break down.

The reaction in the case of men in Groups D, E, F, and G seemed to be due to the serum rather than to the vaccine, as the toxic effects due to the serum is apparent so much earlier than those due to the vaccine, which makes itself apparent about the fourth to sixth days. Probably a reduction in the amount of serum given would lessen the reaction in these groups.

(*d*) *The Agglutinin Production in the Blood of the Inoculated Men.*

The accompanying tables show the height to which the agglutinins for the various types of dysentery are raised by the use of the vaccines given. Table XI gives the agglutination titres ten days after the second dose, and shows the difference in the end-points ten days and one month after inoculation.

Ten days after inoculation there appears to be very little to choose between the various vaccines with regard to the amount of agglutinin formed, with the exception that there is no appreciable formation of agglutinins in Group G—the group in which the whole serum was mixed with the vaccine. Group F1 gave the best agglutinins for the Flexner and "Y" types, while there was nothing to choose between them with regard to the Shiga type. At the same time it is certain that the higher second doses in groups E1 and F1 give better agglutinins than the lower second dose in groups E2 and F2.

TABLE XI.—Agglutination Titres.
(*Ten days after inoculation and one month after.*)

	B. dysenteriæ (Shiga)			*B. dysenteriæ* (Flexner)			*B. dysenteriæ* "Y"		
	Titre prior to inoculations	Titre 10 days after 2nd dose	Titre 1 month after 2nd dose	Titre prior to inoculations	Titre 10 days after 2nd dose	Titre 1 month after 2nd dose	Titre prior to inoculations	Titre 10 days after 2nd dose	Titre 1 month after 2nd dose
Group A, Nos. 51—55	*Nil*	1—200	1—150						
,, ,, 56—60	1—20	1—100	1—75						
,, ,, 61—65	*1—10	1—150	1—150						
,, ,, 66—70	*Nil*	1—100							
Group D, Nos. 91—93	1—10	1—100	1—100						
,, ,, 94—97	1—20	1—150	1—100						
Group E1, Nos. 1— 5	*Nil*	1—200	1—75	*1—20	1—150	1—100	*1—20	1—100	1—100
,, ,, 6—10	1—20	1—100	1—75	1—20	1—100	1—100	1—20	1—100	1—75
,, ,, 11—15	*Nil*	1—300	1—75	1—20	1—150	1—100	*1—10	1—150	1—75
Group E2, Nos. 16—20	1—20	1—75		1—20	1—100		1—10	1—75	
Group F1, Nos. 21—25	*Nil*	1—100	1—100	1—20	1—150	1—100	*Nil*	1—75	1—75
,, ,, 26—30	1—50	1—300	1—150	1—20	1—150	1—150	1—10	1—150	1—75
,, ,, 31—35	*Nil*	1—100		1—10	1—150		*Nil*	1—150	
Group F2, Nos. 36—40	*1—20	1—75		*1—10	1—75		*Nil*	1—75	
Group G, Nos. 41—45	*Nil*	1—20		1—20	1—20		*Nil*	1—50	
,, ,, 46—50	1—20	1—20		I—10	1—20		*Nil*	1—50	

* = Trace of agglutination.

The sera which were not tested again one month after inoculation are shown blank.

Between Groups A and D again there is little to choose.

In all cases the agglutinins for Flexner and "Y" types are lower than one would expect.

One month after inoculation the agglutination titre had dropped in most cases. The drop was most marked in the cases of the higher Shiga titres, while the titres for Flexner and "Y" had fallen to a lesser extent.

The titres obtained from the groups of men inoculated at Aldershot correspond very closely to those obtained with the men inoculated in the preliminary experiments with Shiga vaccine alone.

(*e*) *The Protective Power of the Serum of the Inoculated Men when mixed with a known Number of Lethal Doses of Shiga Toxin and Inoculated into Rabbits.*

Dr. R. A. O'Brien again kindly undertook to carry out these experiments for me.

The serum remaining over from the men of each group after the agglutinin estimation was pooled and sent to the Wellcome Physiological Research Laboratories. The amount of serum obtainable from the various groups differed in amount, so that the same amount of serum could not be utilized in each case. The serum was mixed with 0·25 milligramme (five minimal lethal doses) of Shiga toxin and inoculated into rabbits, with the following results. The experiments were controlled with normal human serum.

TABLE XII.—SERUM DRAWN TEN DAYS AFTER THE SECOND INOCULATION.

	Amount of serum mixed with toxin	Amount of toxin given	Result
Control	—	0·1 mgm.	Rabbit died 2nd day
,, ...	—	0·05 ,,	,, ,, ,,
Normal man	1·0 c.c.	0·25 ,,	,, ,, ,,
,, ,, ...	1·0 ,,	0·25 ,,	,, ,, ,,
,, ,, ...	1·0 ,,	0·1 ,,	Rabbit survived
,, ,, ...	1·0 ,,	0·25 ,,	Rabbit died 2nd day
Group A	1·0 ,,	0·25 ,,	Rabbit survived
,, D	0·5 ,,	0·25 ,,	Rabbit died 5th day
,, E	0·5 ,,	0·25 ,,	Rabbit died 2nd day
,, F	1·0 ,,	0·25 ,,	Rabbit survived

TABLE XIII.—SERUM DRAWN ONE MONTH AFTER THE SECOND DOSE.

	Amount of serum mixed with toxin	Amount of toxin given	Result
Normal man	1·0 c.c.	0·15 mgm.	Rabbit died 3rd day
,, ,, ...	1·0 ,,	0·15 ,,	,, ,, ,,
,, ,, ...	1·0 ,,	0·15 ,,	,, ,, ,,
,, ,, ...	1·0 ,,	0·15 ,,	,, ,, ,,
Group A	0·5 ,,	0·25 ,,	Rabbit survived
,, D	0·75 ,,	0·25 ,,	,, ,,
,, E	1·0 ,,	0·25 ,,	Rabbit died 6th day
,, F	0·75 ,,	0·25 ,,	Rabbit died 5th day

From the above tables there appears to be a definite antitoxic protection in the blood of inoculated men, and this confirms the results obtained in the case of Pte. H. in Part II of this paper. In that case 0·5 cubic centimetre of serum from Pte. H. was mixed with 0·25 milligramme of toxin and the rabbit survived. The same result was obtained both when the blood was drawn off ten days and one month after his second dose of vaccine. This seemed to indicate that the potency of the serum does not change much

during the first month after the administration of the vaccine, and in this respect man conforms to much the same rules as the horse.

Rabbits tested with normal human serum do not survive more than three days after a test dose of one cubic centimetre of serum mixed with 0·15 milligramme toxin.

In Group A in the above tables there is strong evidence of good antitoxic protection, 0·5 cubic centimetre of the serum from men in this group protecting a rabbit against five minimal lethal doses of toxin, even when the serum was tested one month after inoculation of the men. Group D, the parallel group to Group A, again shows good protection. Ten days after the men were inoculated 0·5 cubic centimetre of their pooled serum enabled the rabbit to live until the fifth day, while normal human serum fails to protect the rabbit beyond the second day when the same dose of toxin is given. As 0·75 cubic centimetre of the serum drawn one month after inoculation gave complete protection it is practically certain that if enough serum had been available to give the rabbit this amount in the first instance it would have been fully protected.

In Group E 0·5 cubic centimetre of serum drawn off ten days after inoculation failed to produce any evidence of protection, but 1·0 cubic centimetre of serum tested one month after inoculation enabled a rabbit to live for six days after five minimal lethal doses of toxin, showing certainly some protection. Again, in Group F the serum drawn off after one month after the inoculation of the men produced some evidence of protection, in that 0·75 cubic centimetre of serum enabled the rabbit to survive until the fifth day. As one cubic centimetre of serum tested ten days after the giving of the vaccine fully protected a rabbit against five minimal lethal doses it may be inferred that one cubic centimetre would have protected the rabbit at the later date.

The serum obtained from the groups of men inoculated at Aldershot all show distinct antitoxic immunity and of these groups A and D seem to be slightly the best.

(*f*) *Conclusions on the Aldershot Experiments.*

(1) The reaction after the administration of eusol killed vaccine is too severe for practical use, also the agglutinins formed are not higher in amount than those formed when vaccine killed with carbolic is given with absorbed anti-dysenteric serum. The

antitoxic products in the serum of the inoculated individuals is slightly higher, but very little more so than in the parallel Group D.

(2) Dysentery vaccine containing all three principal types of bacilli can be given if mixed with anti-dysenteric serum. If the serum is first absorbed with the strains of the types of bacilli used in the vaccine, agglutinins are produced in the blood of inoculated individuals, while the local serum disease in the form of urticaria is less marked after the serum has been absorbed and filtered than it is if the serum is given mixed with the vaccine in its untreated state. Whether the serum is mixed with the vaccine at the time of preparation or at the time of administration seems of little moment with regard to the production of agglutinins, but the local reaction immediately following the inoculation is slightly more marked in the first case. The reaction appears to me to be due to the serum rather than to the vaccine; from recent animal experiments it seems probable that the amount of serum, at present 0·5 cubic centimetre, given with the vaccine could be substantially reduced, as 0·05 cubic centimetre of serum protects a rabbit of 1·2 kilos against a dose of killed Shiga which was sufficient to kill a rabbit of 3·4 kilos. This reduction of the amount of serum mixed with the vaccine will probably reduce the amount of local reaction in man still further.

(3) The relapse of trench nephritis in the case of one man who was inoculated, although only slight, points to the fact of a man having had this disease being a contra-indication against inoculation. As the men who suffer from this disease almost certainly are left with damaged kidneys it is quite possible that inoculation with any kind of vaccine, so long as it was at all toxic, as T.A.B., might produce similar relapses.

PART IV.

Further Experiments with Larger Doses of the Vaccine and Smaller Doses of the Absorbed Serum.

After consideration of the Aldershot experiments some further experiments were started to determine the smallest amount of serum that could be given to ensure the same results without any increase of the reaction. I was of opinion that the reaction might even be lessened by these means, as some of the immediate reaction seemed to me to be due to serum and not to the vaccine at all. Also experiments were carried out to note the effect of raising the dose

of *B. dysenteriæ* (Flexner) and *B. dysenteriæ* ("Y") on the agglutinin production in inoculated individuals.

Experiment 1.—This experiment was carried out in order to determine whether the absorbing and filtering of the serum reduced its antitoxic properties to any marked extent, and also the minimum amount of serum required to protect a rabbit against 500 million *B. dysenteriæ* (Shiga). Of course, each batch of serum that is put through the process requires titrating in this way.

In the case of this experiment the test dose of *B. dysenteriæ* (Shiga) was 600 millions.

Six rabbits were inoculated subcutaneously with a constant amount of vaccine and varying amounts of serum.

TABLE XIV.

	Dose of vaccine	Amount of serum	Result
Rabbit No. 57 ..	600 millions ..	0·125 c.cm. untreated serum..	No ill effects
,, ,, 58 ..	,, ,, ..	0·05 ,, ,, ,, ..	,, ,,
,, ,, 59 ..	,, ,, ..	0·01 ,, ,, ,, ..	,, ,,
,, ,, 60 ..	,, ,, ..	0·12 c.cm. absorbed serum ..	,, ,,
,, ,, 61 ..	,, ,, ..	0·05 ,, ,, ,, ..	,, ,,
,, ,, 62 ..	,, ,, ..	0·01 ,, ,, ,, ..	Died on 5th day
,, ,, 63 ..	,, ,, ..	CONTROL, no serum ..	Died on 2nd day

From this experiment it is evident that the process of absorption and filtering removes a certain amount of the antitoxin as one would expect to be the case, but that 0·05 cubic centimetre of this serum is sufficient to protect against 600 million *B. dysenteriæ* (Shiga). In other words this amount of serum neutralizes the toxin of the dose of dysentery vaccine given to man.

Experiment 2.—The next experiment consisted of giving the same dose of vaccine as was given to the men at Aldershot mixed with a smaller amount of serum. As 0·05 cubic centimetre was sufficient to protect a rabbit it was decided to give twice the amount, i.e., 0·1 cubic centimetre to man and thus be on the safe side.

D. H. was given 500 million *B. dysenteriæ* (Shiga), 250 million *B. dysenteriæ* (Flexner), and 250 million *B. dysenteriæ* ("Y") mixed with 0·1 cubic centimetre absorbed and filtered serum. There was some flush and tenderness round the site of inoculation on the same evening. On the following morning there was slight headache. There was no swelling of the arm, but the flush still remained. This had passed off in forty-eight hours, and at this time Indian clubs could be swung without any discomfort.

Eight days later the second dose was given.

This second dose was an increase on that given at Aldershot, in that 1,000 million each of Flexner and "Y" bacilli were given instead of 500 million of each, while the dose of 1,000 million Shiga was the same as that given before at Aldershot for the second dose. This dose was contained in 0·5 cubic centimetre of the vaccine and was mixed with 0·2 cubic centimetre of absorbed serum.

The arm was tender, and "shivering" with a feeling of malaise was experienced the same evening as the inoculation. There was again slight headache on the following morning. At this time there was no swelling of the arm but a flush over the biceps which cleared up in forty-eight hours.

On the second morning after inoculation Indian clubs could again be swung.

AGGLUTININ PRODUCTION.

	Before inoculation	5 days after 1st dose	After 2nd dose: 4 days	10 days	1 month
Shiga	*Nil*	1—20	1—20	1—75	1—75
Flexner	"	1—20	1—100	1—150	1—100
"Y"	"	1—75	1—100	1—100	1—100

The reaction in this case was less than the majority of the reactions noted after the inoculations at Aldershot.

Experiment 3.—The following experiment was done in order to note the reaction after using the most toxic strain of *B. dysenteriæ* (Shiga) that was available. The minimal lethal dose of this strain was 50 million bacilli when inoculated living intravenously into rabbits.

A. G. R. F., received 500 millions of this toxic strain killed by carbolic and mixed with 0·1 cubic centimetre of absorbed serum. This was inoculated subcutaneously into the forearm. On the same evening he suffered from "shivering" and headache. On the following morning the headache was still present. This cleared up during the day. Locally there was some swelling of the forearm on the same evening as the inoculation accompanied with a dull pain that extended into the hand. On the following day there was a flush round the site of inoculation, but no swelling. The forearm was still painful, and slight tenderness remained on deep pressure for four days. The second dose was given on the fifth day after the first and contained 1,000 million bacilli of the same strain mixed with 0·2 cubic centimetre of absorbed serum. This was again inoculated subcutaneously into the forearm.

There was no general reaction. The local reaction came on

during the evening after inoculation. It was at first more marked than that experienced after the first dose with more swelling. At the same time it was very much more transient and had disappeared entirely in forty-eight hours.

The reaction was not excessive after either dose.

AGGLUTINATION TITRE.

Before inoculation		5 days after 1st dose		10 days after 2nd dose
1—20	..	1—75	..	1—150 (trace in 1—200)

Experiment 4.—I then determined to reinoculate myself. The result of the first inoculation was shown in Part II of this paper. At that time *whole* serum was used to neutralize the toxin of the bacilli and this inoculation produced no agglutinin, bactericidins, or antitoxin in my serum (see Part II under heading H. G.).

An interval of four months was considered sufficient time to have elapsed in order to again take myself as normal.

The first dose consisted of 500 million *B. dysenteriæ* (Shiga) mixed with 0·1 cubic centimetre *absorbed* serum.

The same evening there was slight headache and a feeling of malaise, also some tenderness of the upper arm. This passed off during the night and there was no inconvenience on the following day. Three days after inoculation slight tenderness again appeared at the site of inoculation, though not enough to prevent any kind of manual labour being undertaken. This had gone off again in about forty-eight hours.

Seven days later a second dose of 1,000 million bacilli was received mixed with 0·2 cubic centimetre of absorbed serum.

There was considerable tenderness of the arm the same evening with a feeling of slackness, but no headache or malaise. On the following morning there was a flush over the upper arm. Forty-eight hours after inoculation the flush still remained, but was fading, and there was only tenderness on deep pressure and that only slight in amount.

At no time after inoculation was the local reaction severe enough to prevent any exercise being indulged in.

AGGLUTINATION TITRES.

Before inoculation		7 days after 1st dose		2 days after 2nd dose		4 days after 2nd dose		10 days after 2nd dose
Nil	..	1—20	..	1—20	..	1—20	..	1—150
		(+++)	..	(+)	..	(++)	..	(++)

This shows a great difference to the result obtained with my serum after inoculation with the vaccine mixed with the untreated serum when no agglutinins could be demonstrated in it.

A sample of the serum taken on the tenth day after inoculation was sent to Dr. R. A. O'Brien, at the Wellcome Physiological Research Laboratories, to be tested as to its antitoxic properties.

ANTITOXIN CONTENT.

Amount of serum used to neutralize toxin		Amount of toxin used		Result
0·5 c.c.	..	0·25 mgm. (5 M.L.Ds.)	..	Rabbit survived with no loss of weight
Control (no serum)	..	0·05 mgm.	..	Rabbit died 2nd day

This again shows a marked contrast to the result obtained after the previous inoculation with the vaccine mixed with the untreated serum, when 1·5 cubic centimetres of the serum failed to protect a rabbit against the same number of minimal lethal doses.

From this experiment it is fairly obvious that whereas with Shiga vaccine mixed with untreated serum results are not at all satisfactory, yet when the serum is first absorbed with the homologous organism the results distinctly point to an immunity being established.

As these two experiments were carried out in the same individual no personal idiosyncrasy can enter into the problem, and I think the superiority of the second method over the first is fully established.

Experiment 5.—This experiment consisted of giving five men two doses of the sero-vaccine containing 500 millions each of *B. dysenteriæ Shiga, Flexner,* and "Y" mixed with 0·1 cubic centimetre of absorbed and filtered serum. The second dose was given on the seventh day after the first except in the case of No. 1, who received his second dose on the ninth day. This second dose consisted of 1,000 million *B. Shiga*, 1,000 million *B. Flexner*, and 1,000 million *B. dysenteriæ* "Y" mixed with 0·2 cubic centimetre of absorbed serum.

None of these five men had reactions which were in any way excessive. It may be noted that Nos. 3 and 5 who had the most marked reactions after the first dose had the least reaction after the second.

The œdema which was a feature of the reaction after the second dose in No. 4, was, I think, due to the serum for the following reasons. Œdema due to Shiga toxin does not make its appearance as a rule until the fourth to sixth days after inoculation and is accompanied by much pain. In this case the œdema was present on the day after the injection and was not accompanied by much

pain, also it very readily responded to treatment with calcium lactate.

REACTIONS NOTED AFTER INOCULATION.

After First Dose.	*After Second Dose.*
No. 1.—Slight general and local. Passed off in forty-eight hours.*	No general reaction, and practically no local.
No. 2.—No general reaction. Slight local lasting forty-eight hours.	Slight general reaction, and rather more local than after the first dose. Passed off in forty-eight hours.*
No. 3.—Headache and "shivering" the same evening, with a feeling of nausea lasting through the following day. Flush round site of inoculation persisted after forty-eight hours, but no pain or tenderness.	No general reaction until forty-eight hours after, when urticaria made its appearance. The local reaction was less than after the first dose.
No. 4.—"Shivering" the same evening as the inoculation. The local reaction consisted of stiffness and swelling. A flush remained at the end of forty-eight hours with a "feeling as if the arm had been bruised."	"Shivering" the same evening as inoculation. The local reaction more marked than after first dose. At the end of forty-eight hours there was a good deal of œdema and slight tenderness. However, he was not prevented from doing his ordinary work. The tenderness had disappeared on the morning of the third day.
No. 5.—Very slight general reaction. The arm was swollen, red, and stiff. At the end of forty-eight hours there was still some swelling and stiffness, but only slight tenderness.	No general reaction. The local reaction was much less than after first dose, lasting forty-eight hours.

* There was a slight return of tenderness on the fourth day after these inoculations, but not enough to cause any inconvenience.

This œdema and the occurrence of urticaria in another man failed to justify my belief that the smaller dose of serum would do away altogether with the local and general manifestations due to serum. However, I think that this will be found to be the case in the majority of cases, while certain individuals who are more than usually sensitive to serum are still likely to suffer from urticaria or œdema for a day or so. Even if this is the case this slight discomfort is negligible if immunity against bacillary dysentery can be obtained.

These sera show a good deal of variation in their agglutinin content. It will be noted that the sera of all the other men were better in this respect than that of No. 1, in which case nine days elapsed between the first and second doses.

TABLE XV.—AGGLUTINATION TITRES.

		Titre before inoculation	Titre 10 days after 2nd dose
No. 1	*B. Shiga*	*Nil*	1—75
	B. Flexner	1—10*	1—75
	B. Dysenteriæ "Y"	1—10*	1—100
No. 2	*B. Shiga*	*Nil*	1—75 †
	B. Flexner	,,	1—150 †
	B. Dysenteriæ "Y" ..	1—20	1—200 †
No. 3	*B. Shiga*	1—10	1—150
	B. Flexner	1—20	1—200
	B. Dysenteriæ "Y" ..	1—20	1—150
No. 4	*B. Shiga*	*Nil*	1—150
	B. Flexner	1—20	1—300
	B. Dysenteriæ "Y" ..	1—50*	1—500
No. 5	*B. Shiga*	*Nil*	1—200 †
	B. Flexner	1—50*	1—500 †
	B. Dysenteriæ "Y" ..	1—20	1—200 †

* Denotes a trace of agglutination.
† Serum tested on the thirteenth day after the second dose.

This fact, together with the fact that antitoxin was not produced in this serum in sufficient quantity to protect a rabbit against five minimal lethal doses, suggests that nine days is too long to wait between the doses. The increase in the dose *B. dysenteriæ* (Flexner) and "Y" gives a higher agglutinin content of the serum in these men over those who were inoculated with the smaller doses of these two organisms in the Aldershot experiments.

PART V.

(a) The Preparation of the Vaccine at the Royal Army Medical College.

This may be divided into two parts: (*a*) The preparation of the saline suspension of bacilli, and (*b*) the preparation of the serum.

(*a*) *Preparation of the Bacterial Suspension.*—Four strains of *B. dysenteriæ* (Shiga) are used: (1) L. a toxic strain which has been grown on agar for some years; (2) H. a recently isolated toxic strain from France; (3) W. a recently isolated strain from Egypt, and (4) F. a less toxic strain isolated recently in France.

These four strains are inoculated into four broth flasks and grown at 37° C. overnight. On the following morning Roux bottles containing trpysin agar are inoculated from the flasks, just enough broth culture being run in to enable the surface of the agar to be covered. The bottles are placed in the 37° C.

incubator and the resulting growths washed off on the next morning with normal saline. The suspensions are all collected into one flask and thoroughly mixed.

A sample is then taken for a purity test and also one for standardizing the vaccine. This is carried out in a shallow cell-counting chamber by dark-ground illumination. The suspension of bacilli is diluted to a strength of 12,000 million organisms per cubic centimetre, and is killed by the addition of carbolic acid of a strength of one per cent. The strains of Flexner and "Y" bacilli are prepared in the same way.

After the tests for sterility have proved satisfactory the suspensions of *B. dysenteriæ* (Shiga), *B. dysenteriæ* (Flexner), and *B. dysenteriæ* "Y" are further diluted with normal saline so that the strength of the suspensions are 6,000 million organisms per cubic centimetre, with a 0·5 per cent carbolic content. Equal parts of the Shiga, Flexner and "Y" suspensions are then mixed together bringing the final strength of the vaccine to:

B. dysenteriæ Shiga	.. .. ..	2,000 million	per cubic centimetre.
,, ,, Flexner	.. .. ..	2,000 ,,	
,, ,, "Y"	.. .. ..	2,000 ,,	

Tests are again taken for sterility.

(*b*) *Preparation of the Serum.*—The serum is obtained from the Lister Institute and is as a rule of such potency that 0·01 cubic centimetre mixed with 500 million killed bacilli of the toxic strain L. when injected into a rabbit protects that rabbit against any symptoms of toxæmia.

The serum is then absorbed with the strain of *B. dysenteriæ* (Flexner) used in the vaccine. The supernatant serum is drawn off after the bacilli have sedimented and the sediment is centrifuged in order to recover all the serum. The process is then repeated with *B. dysenteriæ* "Y," and lastly with *B. dysenteriæ* (Shiga). The Shiga absorption is performed last to minimize the time that Shiga bacilli are in contact with the serum in which they might break down and liberate toxin.

This absorption process is carried out in long cylinders which hold one litre at a time.

After the serum has been again centrifuged it is passed through Pasteur-Chamberland filters.

Tests are taken for sterility and the serum is tested again in order to make sure that all agglutinins have been removed by the absorption process.

The antitoxic potency of the serum is then tested. One

twentieth of a cubic centimetre of the serum is mixed with 0·25 cubic centimetre of the vaccine and inoculated into a rabbit. This amount of serum must protect the rabbit against any symptoms of toxæmia.

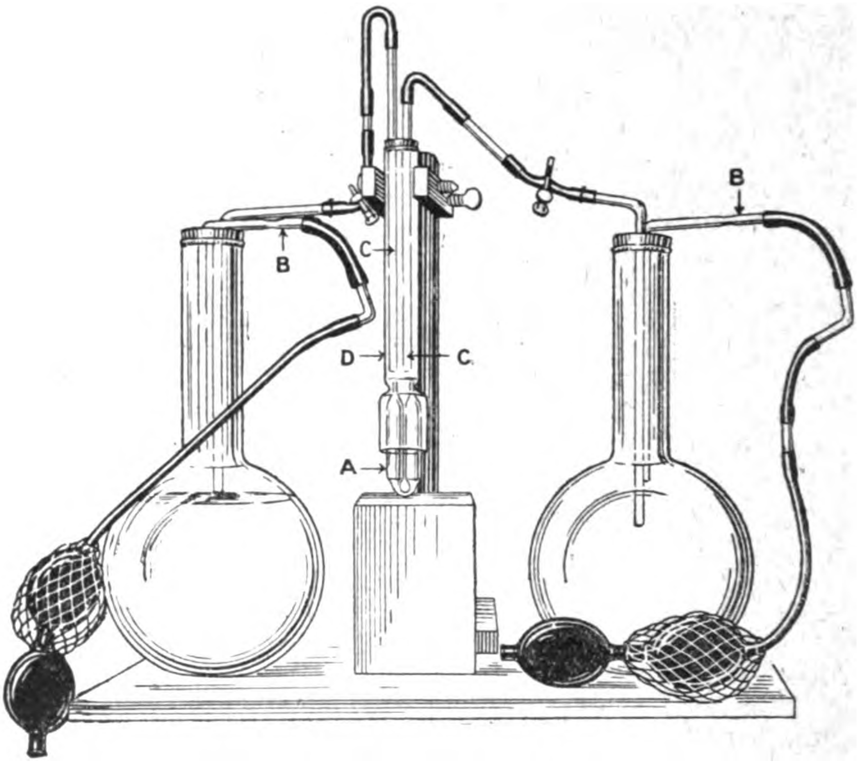


FIG. 4.—Filling apparatus for the twin phials. The flask on the left contains the vaccine, that on the right the serum. The twin phials A are filled by pressure by means of the hand pumps. B B are sterile cotton wool filters. The phials are filled through drawn out capillary tubes C C led through the glass tube D. The flow of vaccine and serum is controlled by means of the pinch cocks.

If this test is satisfactory the serum is diluted so that 0·25 cubic centimetre of the resulting dilution contains 0·1 cubic centimetre of the absorbed serum. The diluted serum is again tested for sterility and then the vaccine and serum are filled into twin phials.

These phials are joined together so that the vaccine and serum are sent out for use together and cannot be separated.

Figs. 4 and 5 show the filling apparatus, the phials, and the label for the phials. Tests for sterility are again taken from the phials. These phials contain five cubic centimetres of vaccine and five cubic centimetres of absorbed serum.

To administer the vaccine the arm is prepared in the ordinary way with iodine and then 0·25 cubic centimetre is withdrawn into the syringe from each phial and inoculated subcutaneously. This first dose consists of 500 million *B. dysenteriæ* (Shiga), 500 million *B. dysenteriæ* (Flexner), and 500 million *B. dysenteriæ* "Y" mixed with 0·1 cubic centimetre of absorbed serum. The second dose,

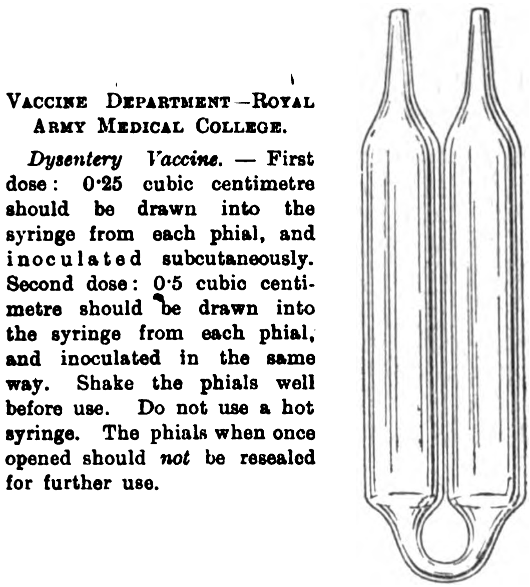


FIG. 5.—The vaccine phials and label. The phials are quite separate, but joined together at the lower end by means of a solid piece of glass.

which should be given seven days later, consists of double the first dose, i.e., 0·5 cubic centimetre from each phial containing 1,000 million *B. dysenteriæ* (Shiga), 1,000 million *B. dysenteriæ* (Flexner) and 1,000 million *B. dysenteriæ* "Y" mixed with 0·2 cubic centimetre of absorbed serum. A third dose, the same in amount as the second, may be given with advantage.

The phials contain enough vaccine and serum for twenty first doses or ten second doses, and with ordinary care the administration of the vaccine is simple.

Care should be taken that the syringe after being sterilized has cooled down before the serum is drawn up into it, so as not to damage the serum. The vaccine should be drawn into the syringe first, up to the 0·25 cubic centimetre mark, and then the serum should be drawn in from its phial to bring the contents of the syringe up to the ½ cubic centimetre mark. The contents of the

syringe are then inoculated subcutaneously, the best site probably being at the insertion of the deltoid muscle.

Owing to the possibility of contamination of the phial containing the serum, the phials should not be resealed for further use when they have once been opened.

(*b*) CONCLUSIONS ON THE WHOLE SERIES OF EXPERIMENTS.

From these series of experiments it appears that prophylactic inoculation against bacillary dysentery has some chance of success.

The animal experiments show that an antitoxic immunity is produced and that this is also the case when man is inoculated is shown by the experiments on man. This antitoxic immunity is not sufficient in itself. The length of time that it lasts has not been fully determined but it shows no dropping off one month after inoculation. An anti-bacterial immunity must also be raised if the bacilli are themselves to be attacked before they can multiply and break down.

As judged by laboratory tests in the way of agglutinin and bactericidin production this can also be done, although the height to which the titre rises differs somewhat according to the individual.

The agglutinins do not rise as quickly after the second dose as they do in the case of the enteric group of organisms, in fact they appear to drop for a day or two.

The length of time that the agglutinin titre remains raised is at present unknown. In one case at least a good titre was present three months after the second dose had been given.

The slight return of tenderness on the fourth or fifth day after inoculation with a really toxic strain of bacilli indicates I think the breaking down of some of the bacilli which have escaped the antitoxic properties of the serum. Although this tenderness is very slight and merely a passing phase it shows the length of time that the body takes to fully deal with the vaccine and points to the fact that the second dose should not be given for a week after the first, while other facts point to the seventh day being the best for the second inoculation.

The Japanese method, using whole serum, is to give the second dose four or five days after the first. Considering the condition of things when whole serum is given mixed with the vaccine it is fairly obvious from these experiments that the vaccine is inert, from the following facts :—

(1) When whole serum is used mixed with the vaccine there is complete absence of reaction other than that due to the serum.

(2) The antitoxin in the serum completely neutralizes the toxin

of the bacilli, and the anti-bacterial substances in the serum neutralize the antigenic properties of the vaccine as regards the production of anti-bacterial substances in the blood of inoculated individuals. This is proved in these experiments by the absence of antitoxin in the blood of men inoculated with vaccine mixed with whole serum, and also by the absence of agglutinins and bactericidins from their blood.

(3) Turning to eusol killed vaccine and vaccine given with absorbed serum, in both cases there is antitoxin present in the blood of inoculated men. This is slightly more in evidence in the case of men inoculated with eusol killed vaccine, which is what is to be expected as no serum is given with the vaccine. There is no choice between the two as regards antibacterial substances produced in the blood. This proves that sensitizing substances have been removed from the serum during the process of absorption and enables the vaccine to produce demonstrable antibodies in the blood of inoculated men while the toxicity of the vaccine is neutralized by the serum.

The reaction with the eusol killed vaccine prevents its use on a large scale. The use of absorbed serum mixed with the vaccine does away with any severe local reaction, and at the same time does not prevent the vaccine producing the anti-bacterial substances in the blood of inoculated men which are considered to be necessary as well as antitoxin.

It is again necessary to record the fact that a man having had trench nephritis is a contra-indication against inoculation. This would probably be true of other vaccines also; in fact, a man who has suffered from this disease is not fit for further general service and so should not require further inoculation.

The vaccine having passed the laboratory tests to satisfaction now passes on to the final experiment, that of trial in the field, which is taking place at the present time.

In conclusion, my thanks are due to Lieutenant-Colonel D. Harvey, C.M.G., R.A.M.C., officer in charge of the Vaccine Department, Royal Army Medical College, for permission to devote myself to this investigation at a time when the personnel of the department was so hard pressed with the routine work and for his readiness in giving me his valuable opinion and help from time to time. They are also due to Dr. R. A. O'Brien for the estimation of the antitoxic content of the serum of inoculated men against his standard toxin, and to the officers, non-commissioned officers and men of the Royal Army Medical Corps, at the Royal Army Medical College and at the Royal Army Medical Corps Depot, who volunteered to be experimented on with the vaccine.

THE DIAGNOSIS AND TREATMENT OF MALARIAL FEVER.

With Illustrating Charts.

By Captain DAVID THOMSON.
Royal Army Medical Corps.

CONTENTS.

(1) Prefatory Note.

Owing to the great interest that has been aroused recently with regard to the treatment of malarial fever, Lieutenant-Colonel Sir Ronald Ross has asked me to write the following account of some extensive and careful researches on the subject carried out by us at the Liverpool School of Tropical Medicine and elsewhere, for a continuous period of nearly four years (1910-1913).

After this laborious and prolonged research, it was very gratifying to learn that practically all of our conclusions were strongly supported by the American school of clinicians and pathologists on the Panama Canal Zone. It must be admitted that the opinions of the latter carried great weight, since, during a period of ten years, they had accumulated in the hospitals on the Canal Zone, careful records (clinical and pathological) of over 100,000 cases. The same physicians, moreover, had been in charge of the hospitals there during practically the whole of that period.

Our views, on the other hand, were obtained chiefly from some 200 cases and our opinions therefore carry weight, not from the immensity of numbers, but from the care with which each was investigated for the sole purpose of obtaining the maximum amount of information possible. Nearly all of our cases were kept in hospital for a much longer period than was necessary, quinine and other drugs were given for varying periods and then withheld, the clinical results and the results of blood examination by special enumerative methods being carefully charted daily in every case. Some 6,000 blood examinations were made on these 200 cases alone. The numbers of parasites and leucocytes were estimated often several times daily, and careful records were kept of the hæmoglobin percentage, etc.

Special investigations were made with regard to crescent and gamete carriers, as this was very important with regard to the transmission of the disease.

Our cases did not come from one locality only, but from many parts of the world, including the Southern United States, Central America, the Amazon Valley and other parts of South America, also West Africa, East Africa, India, China, etc. They comprised malignant tertian malaria, benign tertian, a few cases of quartan and some mixed cases. Some were very acute and recent cases, some were subacute, and some were chronic cases of long duration. Several cases came under our care in a comatose condition, and finally some had blackwater fever. We dealt therefore with malarial fever from many countries, in all its phases.

Our researches have already been published with many scientific details in several papers written by us during the four years period of our work. As the information, however, is more or less scattered and inaccessible to the average army clinician, we have considered it necessary to give here a concise account of our conclusions, more especially with regard to the minimum treatment which we found necessary in order to give a reasonable guarantee of a permanent cure of the disease.

(2) The Different Types of Malaria.

There are three varieties of malaria—benign tertian, malignant tertian and quartan. These can be distinguished from each other clinically as well as by the microscopic examination of the blood.

(*a*) *Benign tertian.*—The classical temperature curve, with a sharp rise every third day as indicated on Chart 1 is very characteristic.

The rise of temperature is very often accompanied by a severe rigor which may last for half an hour or more. During this time the patient feels very ill and cold. After the fever has reached its height profuse perspiration occurs accompanied by a sudden fall in temperature. The diagnostic feature is the sudden rise and fall of the temperature, the whole paroxysm being over as a rule in some eight hours. Benign tertian malaria is not often accompanied by pernicious symptoms such as coma, and it is very seldom followed by blackwater fever.

The benign tertian parasite (*Plasmodium vivax*) is the largest of the three. It circulates in the peripheral blood in all its stages from the young ring forms to the full-grown sporulating forms. The infected red cells are markedly stippled and they are usually much larger than the normal uninfected corpuscles.

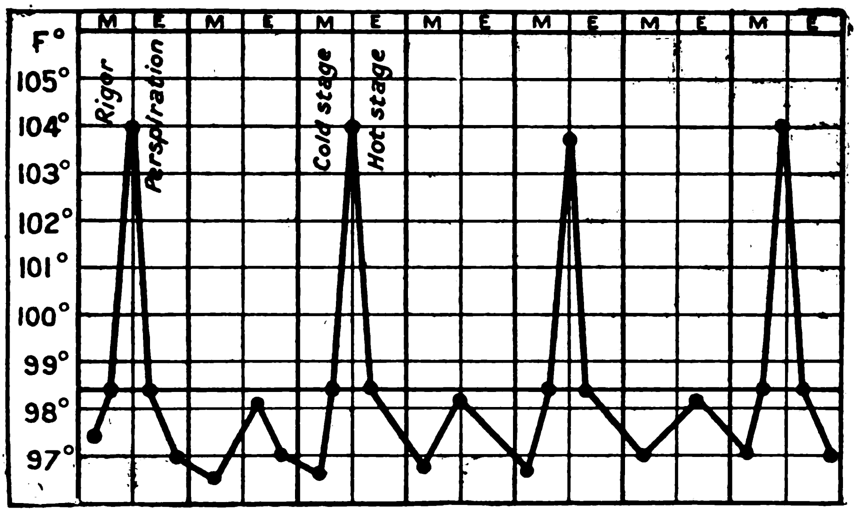
The number of spores produced as a rule is sixteen, and these

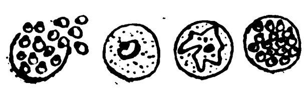
spores or young rings are much larger than those of the malignant tertian parasite.

(*b*) *Malignant Tertian Malaria.*—This is a very good name as this type is, as a rule, much more severe on the patient than the benign tertian variety, and it is also very liable to be accompanied by pernicious symptoms such as coma, severe vomiting, etc.

CHART 1.

Benign tertian malaria (classical type).



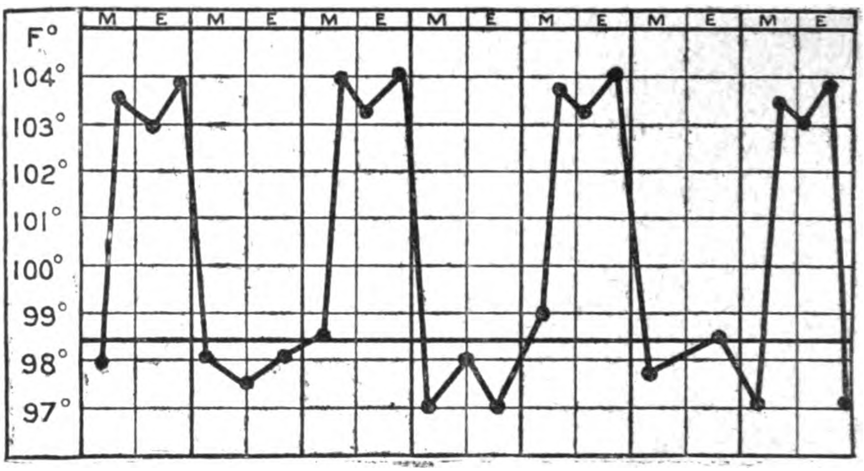


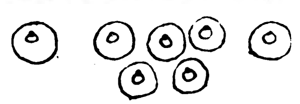
Note that sporulation is synchronous with the rigor and rise of temperature, and that all stages of the parasite are found in the peripheral blood.

If we compare the typical benign tertian fever curve (Chart 1) with the typical malignant tertian fever curve (Chart 2) it is easy to see why the latter is more severe. At a glance we note that the fall of temperature does not occur quickly as in the case of benign tertian. It falls as a rule about half a degree and then rises again, so that the complete paroxysm lasts for some eighteen to twenty hours. Clinically this is the most diagnostic feature of malignant tertian malaria, viz., the long duration of the fever paroxysm. It must be remembered, however, that one does occasionally get short paroxysms in malignant tertian, producing a chart indistinguishable from that of benign tertian fever (*vide* Chart 4). Typical rigors are more common in the benign than in the malignant tertian variety.

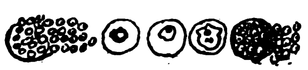
The parasites of malignant tertian malaria (*P. falciparum*) only circulate in the peripheral blood during the young ring stage, so that one very rarely sees the larger semi-adult parasites or the sporulating forms in peripheral blood films. The reason for this will be explained later under paragraph 8. The infected red cells are as a rule shrunken and smaller in size than the normal uninfected corpuscles and they are not stippled with Schüffner's

Chart 2.
Malignant tertian malaria (classical type).





Note that only ring forms are found in the peripheral blood. They are scarce during the paroxysm, but plentiful between the paroxyms.



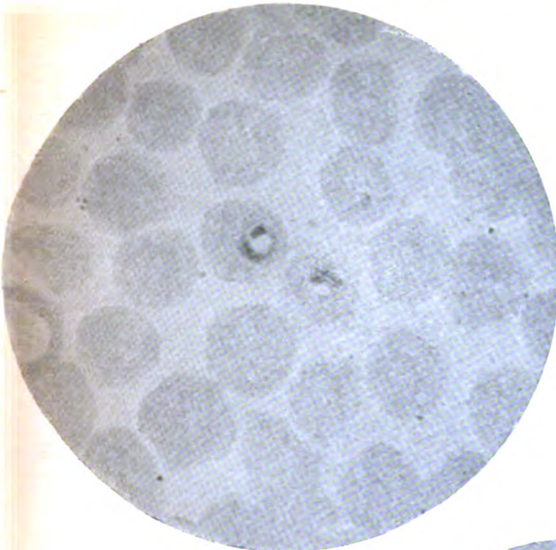
These stages occur only in the capillaries of the internal organs. This is explained later on.

dots as is the case in benign tertian malaria. The maximum number of spores produced by *P. falciparum* is thirty-two,[1] as can be seen in the culture tube and in smears of the inner organs, (Thomson, J. G. and D. (1913), *vide* Plate).

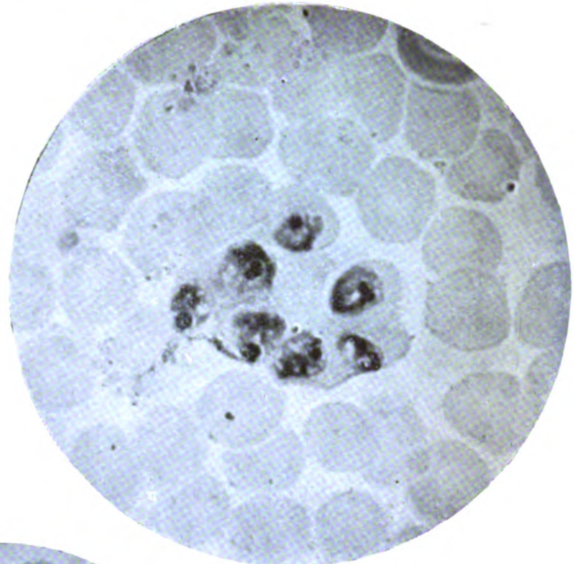
The gametes or sexual forms in malignant tertian malaria are very diagnostic. They are crescentic in shape, whereas those in benign tertian and quartan are spherical.

[1] In smears of the spleen and bone marrow of fatal cases which have received quinine, atypical sporulators may be found containing only eight or nine spores. James (Panama) considers that this atypical sporulation is due to the action of the quinine on the parasite. *Vide* Thomson, D. (1914).

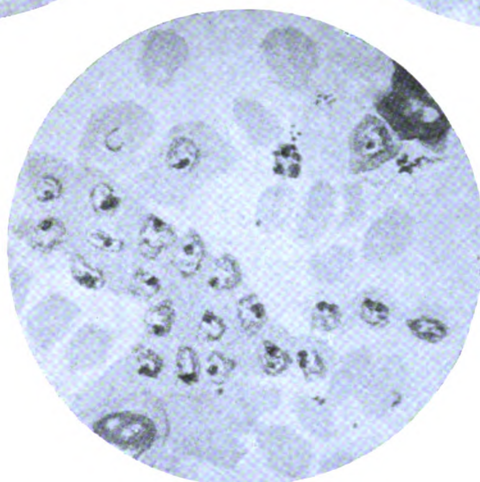
SPORULATION OF THE MALIGNANT TERTIAN PARASITE.



1



2



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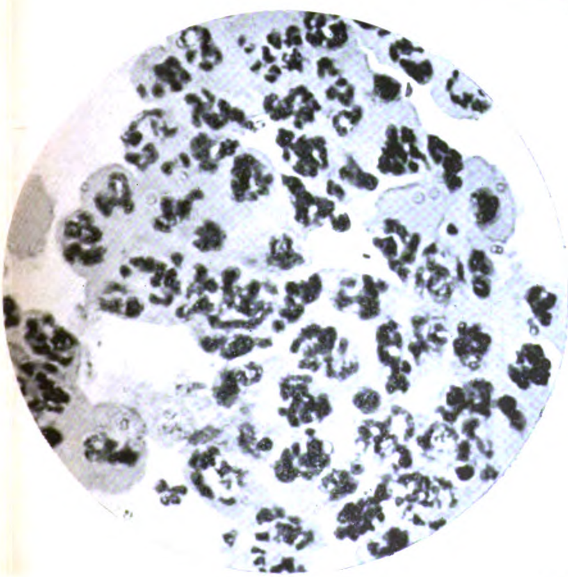
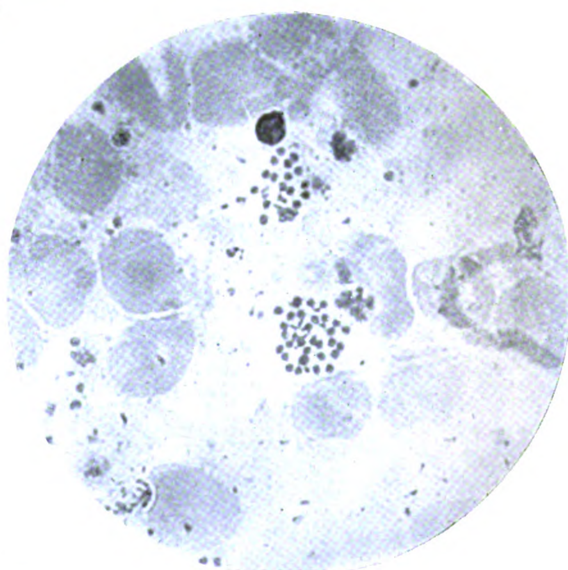


3



4

PLATE.

To illustrate "The Diagnosis and Treatment of Malarial Fever," by Captain DAVID THOMSON, R.A.M.C.

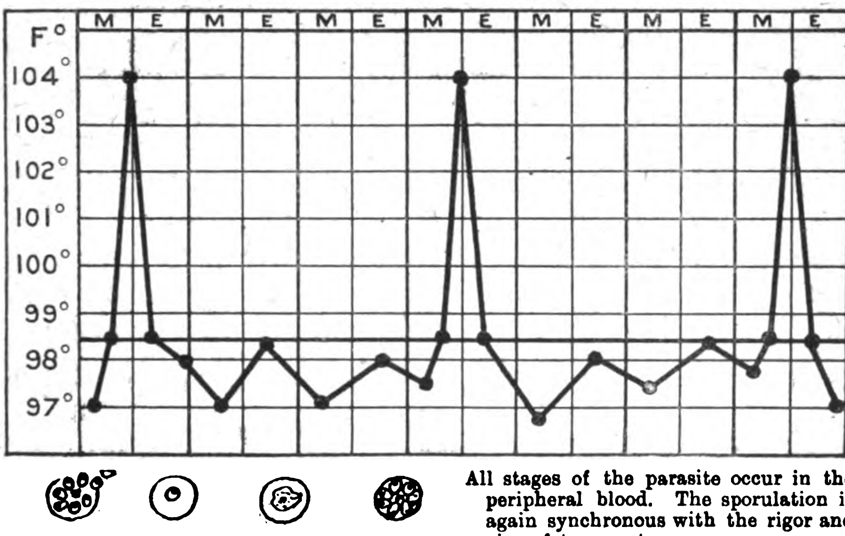
Micro-photographs by Thomson, J. G. and D.

(*c*) *Quartan malaria.*—This form of malaria is quite rare. We had only two cases of quartan amongst our 200 cases. In Panama, the Americans only found twenty cases in about 30,000 patients and Dr. James (1910) states that the total number of cases is so small that the disease may be considered as a curiosity. It is quite common, however, in certain parts of India.

The rise of temperature in quartan malaria, as its name indicates, occurs only every fourth day (Chart 3).

Chart 3.

Quartan malaria (classical type).



All stages of the parasite occur in the peripheral blood. The sporulation is again synchronous with the rigor and rise of temperature.

The paroxysms, as a rule, are sharp and short in duration, as in the case of benign tertian. The disease is, as a rule, mild, but James states that it is more liable to give rise to nephritis than the other two varieties of malaria. It is also stated that it is more persistent and difficult to cure, and therefore the most liable to relapse of the three.

The quartan parasite (*P. malariæ*) circulates in the peripheral blood in all its stages. It produces only about eight to ten spores and it is more coarsely pigmented than the other types.

It is a compact parasite in all its stages and does not show the marked amœboid straggling shapes that are seen in benign tertian (*P. vivax*).

47

It should be noted that the parasites drawn diagrammatically on the charts are the asexual forms. It is the sporulation of these asexual forms which causes the rigor and rise of temperature, presumably due to the liberation of toxins.

The sexual forms do not cause any fever symptoms; as a rule they appear in the peripheral blood late on in the disease and they are found most frequently in chronic cases. These forms will be discussed later.

Some authorities have described other kinds of malaria besides those mentioned above. Marchiafava and Bignami (1894) describe a malignant quotidian, one type due to a pigmented parasite, and another in which the parasite does not contain pigment. These varieties, however, have never been confirmed by other workers. Stephens (1914) has also described a new species of malignant tertian which he has named *P. tenue*. It is quite probable, however, that this is not a new species—*vide* Mary Rowley Lawson (1916). The so-called malignant quotidian described by Marchiafava and Bignami may have been simply a double malignant tertian. At any rate we cannot accept these as facts until they have been definitely proved. The culture tube would be the best way of demonstrating a new species, and it would certainly be a very satisfactory way of showing that the so-called quotidian type really completed its asexual cycle every twenty-four hours.[1]

(3) The Clinical Diagnosis of Malaria.

(*a*) *The Temperature.*—The clinical diagnosis of malaria would be easy if every case showed a classical temperature curve, but I should say that at least half of the cases or more are not classical in this respect. Very many of the patients are infected with two broods of the parasite which sporulate alternately, so that instead of a rise of temperature every other day, we get a daily rise. This is what is called a double tertian fever. In a severe case of double malignant tertian the sporulation of the first brood may not be over before the sporulation of the second brood has commenced, in consequence the temperature remains high all the time. Comatose cases very often show a constant high temperature without remissions to normal. More rarely, comatose cases may exhibit a subnormal temperature, which is a very ominous sign.

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[1] Row (1917) claims to have demonstrated the existence of a malignant quotidian parasite by the cultural method.

Old chronic cases of malaria may only show an occasional slight rise of temperature, and if latent or quiescent, the temperature may remain normal for considerable periods. Mixed malarial infections sometimes occur. It is quite common, for example, to get benign tertian and malignant tertian parasites in the same patient. In such cases the temperature may be very irregular and atypical. It is easy to see, therefore, that for diagnostic purposes we cannot always rely upon the temperature to help us.

(*b*) *Splenic Enlargement*.—This is very common in malaria, especially in chronic cases. In recent cases, however, the enlargement may be imperceptible, more especially if they have received a certain amount of quinine treatment.

(*c*) *Anæmia and Cachexia*.—All cases of malaria show a greater or lesser degree of anæmia, due to the constant breaking down of the red cells. In long-standing badly-treated cases the hæmoglobin percentage may be as low as forty per cent. Such cases usually show a considerable amount of cachexia.

(*d*) *Jaundice*.—Jaundice occurs occasionally in malignant tertian malaria; on the other hand, it is always present in blackwater fever.

(*e*) *Rigors*.—These are very marked and characteristic as a rule in benign tertian, but they are often absent in cases of malignant tertian.

(*f*) *Headache and Pains in the Bones*.—These are the usual accompaniments of nearly all paroxysms of malarial fever.

(*g*) *Vomiting*.—This is very common in malaria during the fever paroxysms. It may be extremely severe and persistent in malignant tertian, thereby constituting what is called a pernicious symptom of this type of the disease.

(*h*) *Quinine Diagnosis*.—The use of quinine is very valuable in clearing up the diagnosis of malaria. If a fever is reduced quickly to normal (in one to two days) by the administration of ten grains of quinine three times daily, this helps to confirm a positive diagnosis. On the other hand the negative quinine diagnosis is more certain, for if we have a fever which is not reduced to normal after three days' administration of quinine in doses of thirty grains daily it is almost a practical certainty that the fever is not malaria.

(*i*) *Diseases which are liable to be confused with Malaria*.—Confusion with malaria is most likely to occur in the case of those internal septic conditions where there is a swinging temperature, often falling each day to normal and in which we can find no outward cause. The periodic rises of temperature in sepsis, moreover, are often accompanied by a rigor, hence such cases as liver abscess,

pyelitis, pyosalpinx, bronchopneumonia, phthisis and typhoid fever, are often mistaken for malarial fever in tropical countries. On one occasion a patient with supposed malaria was admitted to the tropical diseases ward in Liverpool. He had been treated with quinine for three months and was supposed to be a quinine-resistant case. No malarial parasites were found in his blood and it was soon discovered that he was suffering from tropical abscess of the liver. He had a daily periodic rise of temperature until the abscess was evacuated. On another occasion a patient was admitted with a swinging irregular temperature, numerous parasites were found in his blood. These quickly disappeared with quinine treatment, but the temperature still continued to swing, and it was then found that he was also suffering from phthisis. On still another occasion a negro was admitted with a rigor and supposed malaria. His blood was examined immediately and no parasites were found; the film, however, showed an enormous polymorphic leucocytosis, and on clinical examination it was then found that he was suffering from pneumonia. A friend of mine was treated as a malarial patient for three weeks, during which time he received large doses of quinine. It was then discovered that he had been suffering from rheumatic fever. Since malarial fever is often accompanied with severe pains in the bones and muscles, this mistake might easily be made in the tropics in the absence of a blood examination. The resistance to quinine treatment however should in this case have caused the suspicions to be aroused more quickly. One could go on recounting many such cases, more especially in the tropics, where malaria is so frequent and always suspected. It must be remembered that malignant tertian malaria with pernicious symptoms may simulate almost any disease. I had one patient who vomited blood and passed blood in his fæces. Another case developed hemiplegia and still another suddenly became blind in one eye due to petechial hæmorrhages in the retina. Comatose malaria may simulate the alcoholic coma, uræmic coma, sunstroke, apoplexy, etc. The chronic cases of malaria as a rule show considerable anæmia and cachexia with splenic enlargement. They therefore simulate the various anæmias, viz., pernicious anæmia, splenic anæmia and the secondary anæmias. Finally, I would like to mention two extremely interesting cases which came under my care in Liverpool; both were admitted with a history of malaria. The temperature in each remained normal, but they showed a curious mental condition resembling senile dementia. The blood examination revealed a very large number of crescents in

each. These rapidly diminished in number under full daily doses of quinine, whereupon the mental condition became quite normal.

I have given these examples in order to emphasize the difficulties in diagnosing malaria from the clinical signs and symptoms alone. With the aid of the microscope, however, the diagnosis becomes extremely certain and easy, except, I should say, in latent cases which have received quinine. In the older books on malaria many clinical types are described, such as the gastric type, the algid type, the choleraic type, the dysenteric type, and so on. At the time these books were written, the microscope was seldom used and it is quite possible that some of the types described were not malaria at all. Always be sceptical about unusual statements made concerning malarial fever and its treatment, where the diagnosis has not been confirmed with the microscope. Such statements are hardly worth serious consideration.

(4) The Diagnosis of Malaria from the Microscopic Examination of the Blood.

This is by far the most certain and satisfactory way of diagnosing malaria. Although Laveran first discovered the parasite with a $\frac{1}{6}$-inch dry objective, it is really necessary to employ a good microscope with an oil immersion lens. Some experts are very good at finding the parasite in unstained coverslip films of the blood. They are much more easily seen, however, in stained preparations, in either thin blood films or in thick dehæmoglobinized films. The morphology of the parasite is most clearly demonstrated by the former method, but the latter thick film process is most useful for detecting them when they are very scarce.

(*a*) *The Thin Film Method.*—Make a very thin smear of the suspected blood on a clean glass slide, dry quickly in the air and fix by immersing in absolute alcohol, or better still in methyl alcohol, for five to ten minutes. Make up some Giemsa stain[1] about eighteen drops to ten cubic centimetres of distilled water. Dry off the alcohol from the slide and pour on the diluted Giemsa stain. After half an hour or longer wash off the stain in tap water, dry the slide thoroughly and examine it under the oil immersion lens. If the leucocytes are only faintly stained, then one cannot be certain

[1] Any of the Romanowsky stains may be used, and very good results can be obtained more quickly with eosin-azur, Hastings or Leishman's stain.

that the staining is good enough to show up the young ring parasites. If, however, the nuclei of leucocytes are stained deeply one can be sure that the parasites, if present, will be seen distinctly. I have not sufficient space here to go into the details of the appearance of the various stages of the different parasites in stained preparations. These are best studied in coloured plates. I wish to warn the beginner, however, not to mistake a blood platelet superimposed on a red cell for a young ring parasite. It should be noted that a stained blood platelet consists of a mass of small red granules, whereas the parasite is a definite faint blue ring, with a red dot of chromatin. The parasites are very definite bodies and when well stained there is no danger of mistaking them for blood plates. The well-grown parasites such as are often seen in the peripheral blood in benign tertian and quartan malaria contain a considerable number of brownish-black pigment granules. The granules in the quartan variety are larger in size. Crescents and other gametes also contain much pigment.

(*b*) *The Thick Film Method.*—This was originated by Ross (1903) in order to facilitate the finding of parasites when they are very scarce, as occurs in latent malaria with no fever. A drop of blood (several cubic millimetres) is placed on a slide and spread slightly with the needle to form a thick film which is quite opaque. Allow this to dry thoroughly and then dehæmoglobinize it by immersing the slide in a dish of water. When the hæmoglobin is completely dissolved out, remove the slide from the water and stand it in a sloping position until it is dry. Now fix it in alcohol and stain it as already described. In this way the parasites can be concentrated some twenty times, so that in one microscopic field we find twenty times as many as in a corresponding field in a thin film. In this method, however, the parasites do not usually show up quite so distinctly and their appearance is somewhat altered. The young ring forms, for example, do not appear like small rings, but each consists of a red dot of chromatin, to which is attached a small blue tag of protoplasm. W. M. James (1911) found that the number of positive findings of parasites in latent malaria was very much greater with the thick than with the thin film method. I have already made a strong statement with regard to quinine diagnosis and I wish now to make a further more or less dogmatic statement with regard to microscopic diagnosis. Suppose we have a patient showing a rise of temperature above 99° F. or 100° F. and we make a stained blood film during or near the time of this fever, then if no malarial parasites are detected, more especially in a thick

film, it can be stated definitely that this rise of temperature is not due to malaria. On the other hand, small rises of temperature up to 99° F. may occur even during quinine treatment. These are in all likelihood due to the malarial parasite existing in small numbers, though too scanty to be detected in blood films.[1]

(c) *The Number of Parasites required to Produce Fever.*—Our researches in Liverpool, *vide* Ross and Thomson (1910), showed clearly that it required a considerable number of asexual parasites per cubic millimetre of blood to produce a rise of temperature. In benign tertian malaria we found that it took at least 100 adult parasites per cubic millimetre to produce on sporulation a temperature of about 99° F., while temperatures from 100° F. and upwards were only produced by the sporulation of parasites as numerous as 300 per cubic millimetre and upwards. During the actual fever of course these numbers are greatly multiplied, since the adult parasites have broken up into young rings. During benign tertian fever, therefore, the numbers are large enough to be detected on microscopic examination and more especially by the thick film method. In malignant tertian malaria it is more difficult to make such an estimate of the numbers, since the sporulating forms are found only in the blood of the internal organs. With regard to the peripheral blood, however, we found as a rule that a temperature of 99° F. was usually associated with the presence of some 3,000 young ring parasites per cubic millimetre. Temperatures ranging from 99° F. to 106° F. were associated with numbers ranging from 5,000 to 300,000 per cubic millimetre. If a rise of temperature is due to malaria, we are therefore certain to find the parasites on microscopic examination of the blood taken at the time, more especially by the thick film method. I wish, however, to point out one exception, though in reality it is an exception only in theory, because I hardly believe it ever occurs. This exception would be a case of malignant tertian malaria in which all the parasites sporulated at the same time. In such a case during the rise and height of the fever, there would be no parasites in the peripheral blood, because all of them would be sporulating forms lying in the capillaries of the inner organs. It is true that during the fever paroxysms in malignant tertian the young ring parasites are comparatively scarce in the peripheral blood and they become very

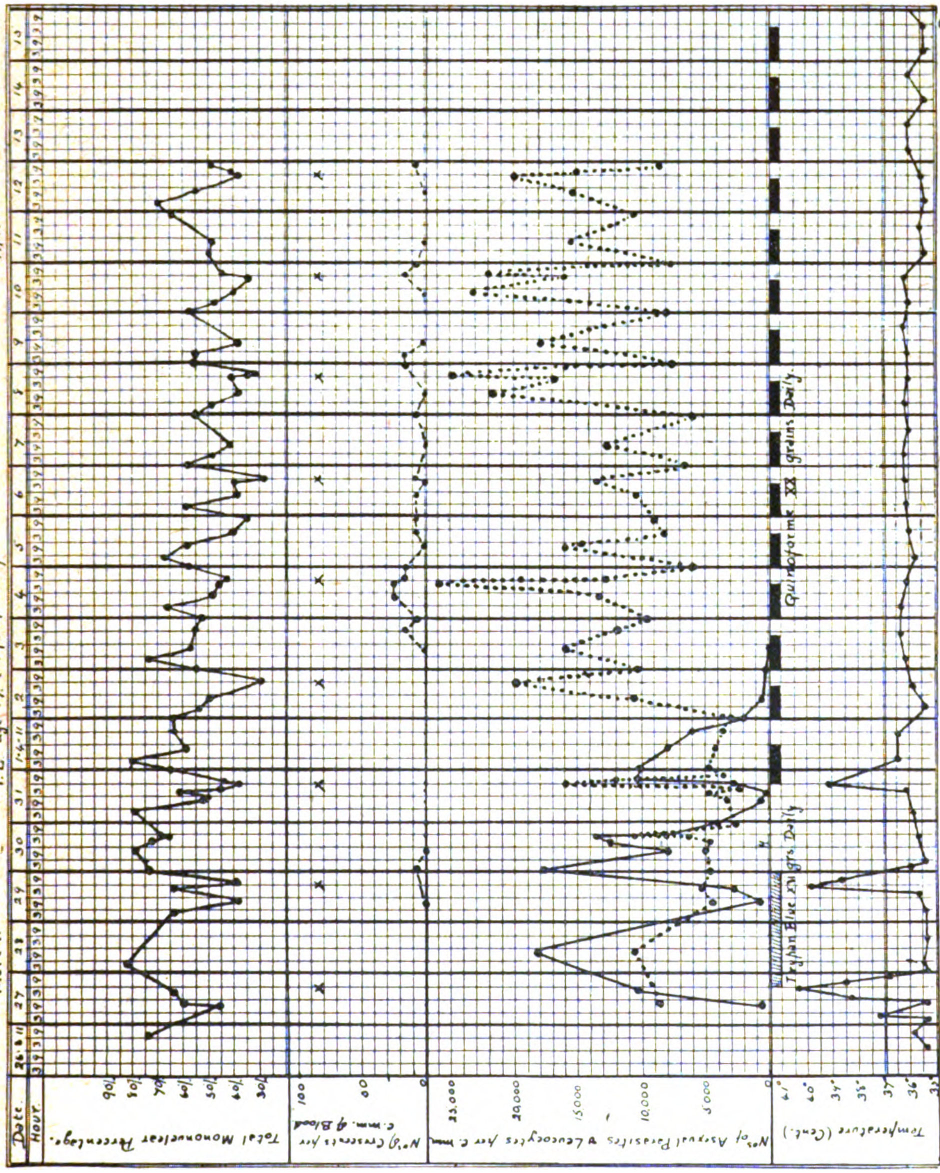
[1] Captain Dudley Forde, R.A.M.C., believes that cases showing periodic rises of temperature up to 99° F. or 99·5° F. during quinine treatment are likely to relapse after the treatment is stopped.

much more numerous when the paroxysm is passing off. But it is also characteristic of malignant tertian malaria that the parasites do not all sporulate at the same time, and this is why we have, as a rule, a paroxysm of some eighteen to twenty hours' duration. Sometimes, however, we may find a case which approaches rather near to the theoretical exception, in that during the height of the fever the parasites are very scarce and difficult to find. In such cases, however, I have always been able to detect them even by the thin film method. The temperature in these cases is very often like a benign tertian temperature, with a sharp rise and a quick fall. Evidently these are cases in which the majority of the parasites sporulate simultaneously in the capillaries of the inner organs. After the paroxysm of fever is over the young ring forms are again found in large numbers in the peripheral blood (see Chart 4).

Sir Ronald Ross had such a case in India. It was not long after Laveran's discovery of the malarial parasite, when blood-staining methods were not in vogue and the parasites had to be detected in wet blood films. One morning he detected in the blood of this case a very large number of young malignant ring parasites. As one of his colleagues was very sceptical about Laveran's discovery, Ross decided to demonstrate to him the parasites in this heavy infection. He brought his colleague to see the patient some hours later when the fever paroxysm was at its height. He was chagrined, however, to find when re-examining the blood that the parasites had vanished, and in consequence his colleague remained more sceptical than ever. Some hours later when his colleague had gone the parasites reappeared in the peripheral blood in large numbers.

(*d*) *The Leucocytes.*—With regard to the diagnosis of malaria strong confirmatory evidence may be obtained from the leucocytes. Malaria is the only disease in which definite blackish-brown pigment is found in the leucocytes in the peripheral blood. The large mononucleated type of leucocyte is able to ingest the parasites and pigment is more often found within them than within the polymorphic variety. The former often contain very large black masses of pigment. Pigmented leucocytes are numerous in very heavy infections and more especially in comatose cases. Another feature in diagnosis is the relative excess of mononucleated leucocytes, more especially of the large mononucleated type. In malarial fever the mononuclear percentage varies inversely with the temperature in a very remarkable manner. When the temperature is rising the number of mononucleated leucocytes in the peripheral blood

CHART 4.



The dotted graph represents the leucocytes.

is falling and vice versa when the temperature falls the mononuclears increase in number. The greatest numbers are found in the period between the paroxysms, when they quite frequently rise as high as eighty per cent of the total leucocytes, *vide* Charts 5, 6 and 7.

CHART 5.

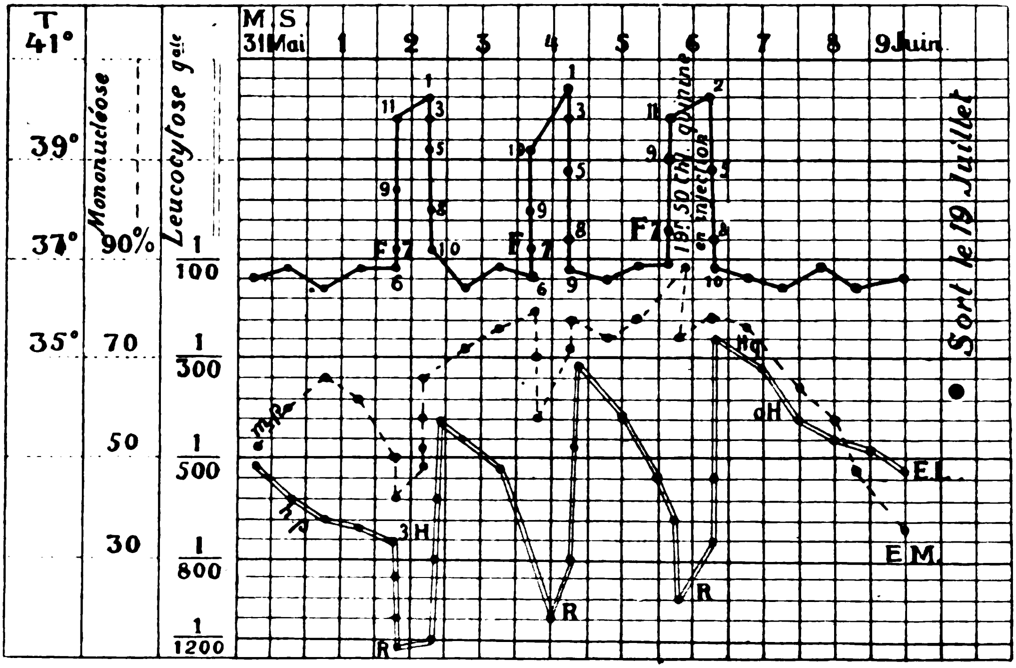


Chart showing the changes in the total leucocytes (and in the percentage of mononuclears large and small) in a case of simple tertian fever. The double line = that of total leucocytes. (After Billet.)

During the height of the paroxysm in malaria there is as a rule a marked leucopenia, often as low as 2,000 leucocytes per cubic millimetre. The one exception to this is comatose malaria, in which very often an enormous leucocytosis occurs, amounting sometimes to 80,000 or even 100,000 per cubic millimetre. In latent cases of malaria showing no fever or detectable parasites in the blood; and also in cases which have been treated thoroughly with quinine, thirty grains daily for several days, one sometimes finds what I have called a post-malarial leucocytosis. In a thorough study of such cases it was found that this leucocytosis occurred as a rule daily, but was very transient in nature lasting only a few hours.

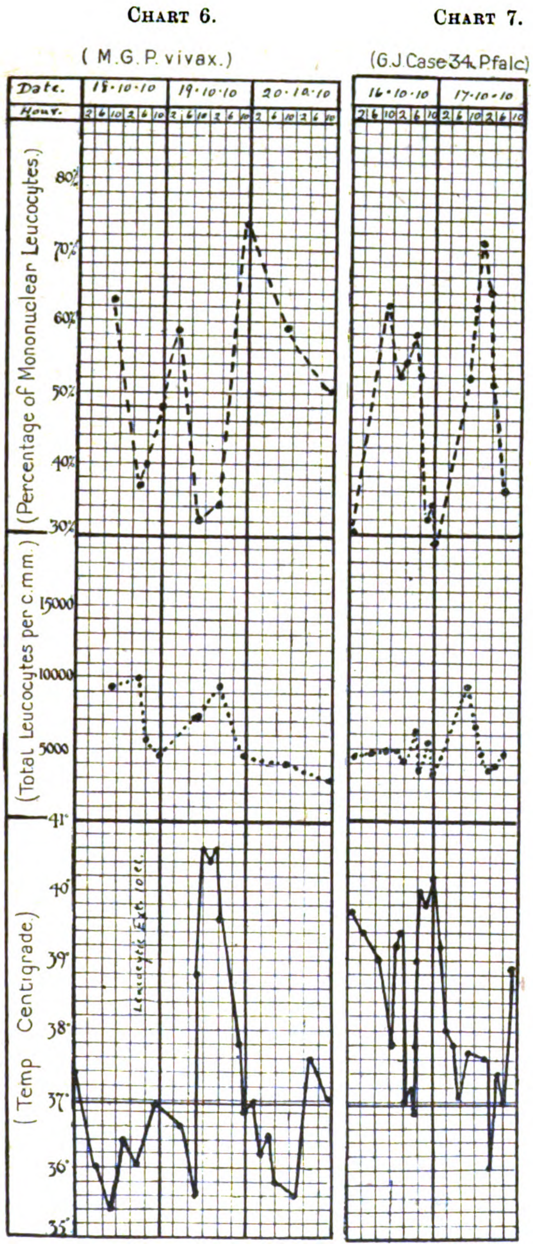
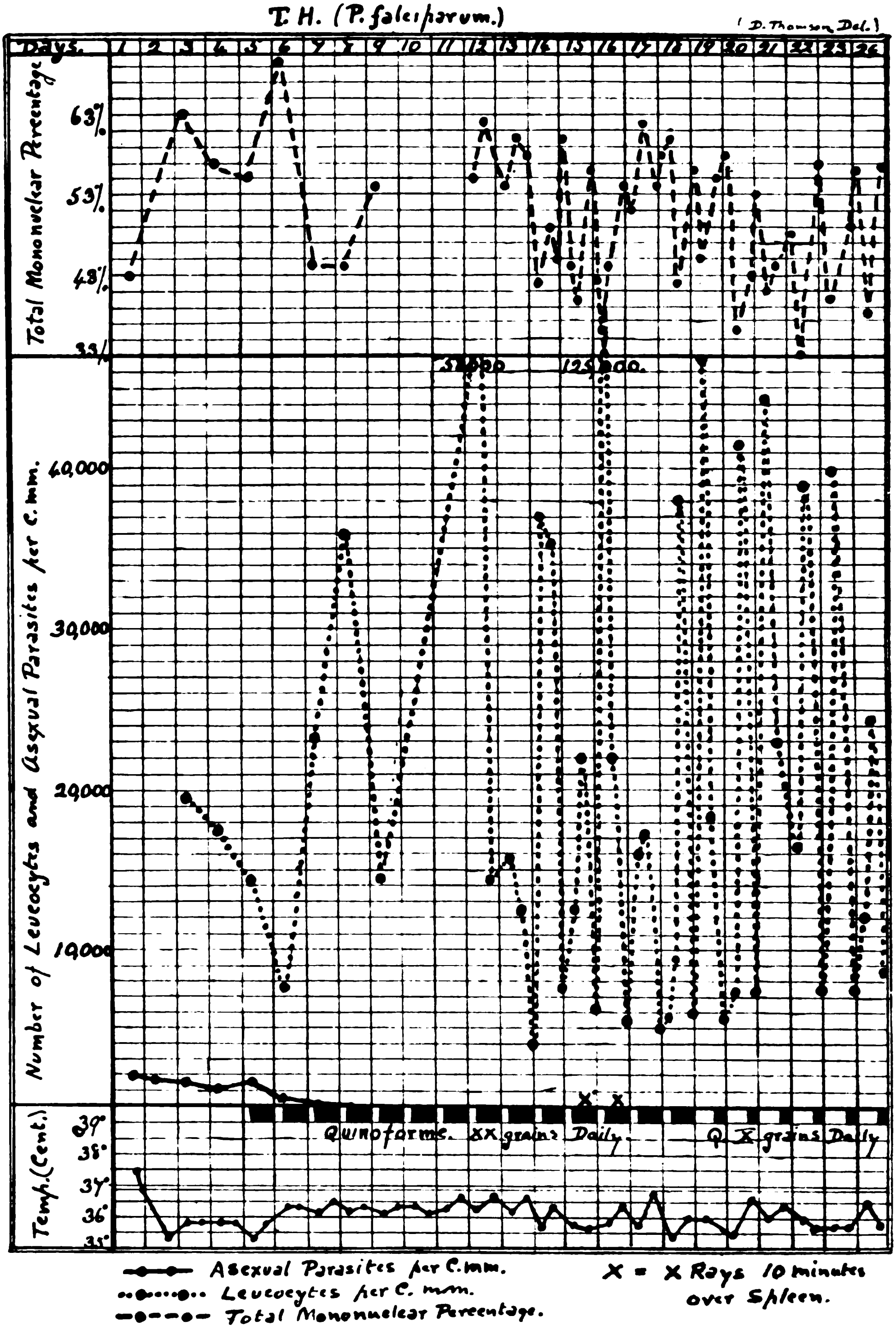


Chart 6.
(M.G.P. vivax.)
Date.
18·10·10
19·10·10
20·10·10
Hour.
(Percentage of Mononuclear Leucocytes.)
80%
70%
60%
50%
40%
30%
(Total Leucocytes per c.mm.)
15000
10000
5000
41°
40°
39°
38°
37°
36°
35°
(Temp Centigrade.)
Chart 7.
(G.J. Case 34. P.falc.)
16·10·10
17·10·10

CHART 8.—Showing a marked post-malarial leucocytosis (periodic).



This phenomenon took place as a rule about the time of the day that the fever paroxysms had occurred during the previous acute stage of the disease. In one case the leucocytes showed a daily swing from about 6,000 to 60,000 per cubic millimetre. It is very difficult to account for this phenomenon. Perhaps it means that the malarial parasites still exist in small numbers, maybe in the spleen and bone marrow. If this is so then it indicates that the disease is very difficult to eradicate, as this periodic leucocytosis was often present after a full course of routine quinine treatment of thirty grains daily by the mouth for three weeks. The post-malarial leucocytosis is as a rule polymorphic in character, *vide* Chart 8.

If we have a fever therefore accompanied with a marked polymorphonuclear leucocytosis, this is against malaria and in favour of sepsis.

If we have a fever with a leucopenia and a marked rise in the percentage of mononucleated leucocytes when the temperature falls, this is very strong confirmatory evidence in favour of malaria.

If we have a case with no fever or parasites and a doubtful history of malaria and we find a high percentage of large mononucleated leucocytes, or if we sometimes find a transient leucocytosis in absence of fever, these are confirmatory signs of latent malaria.

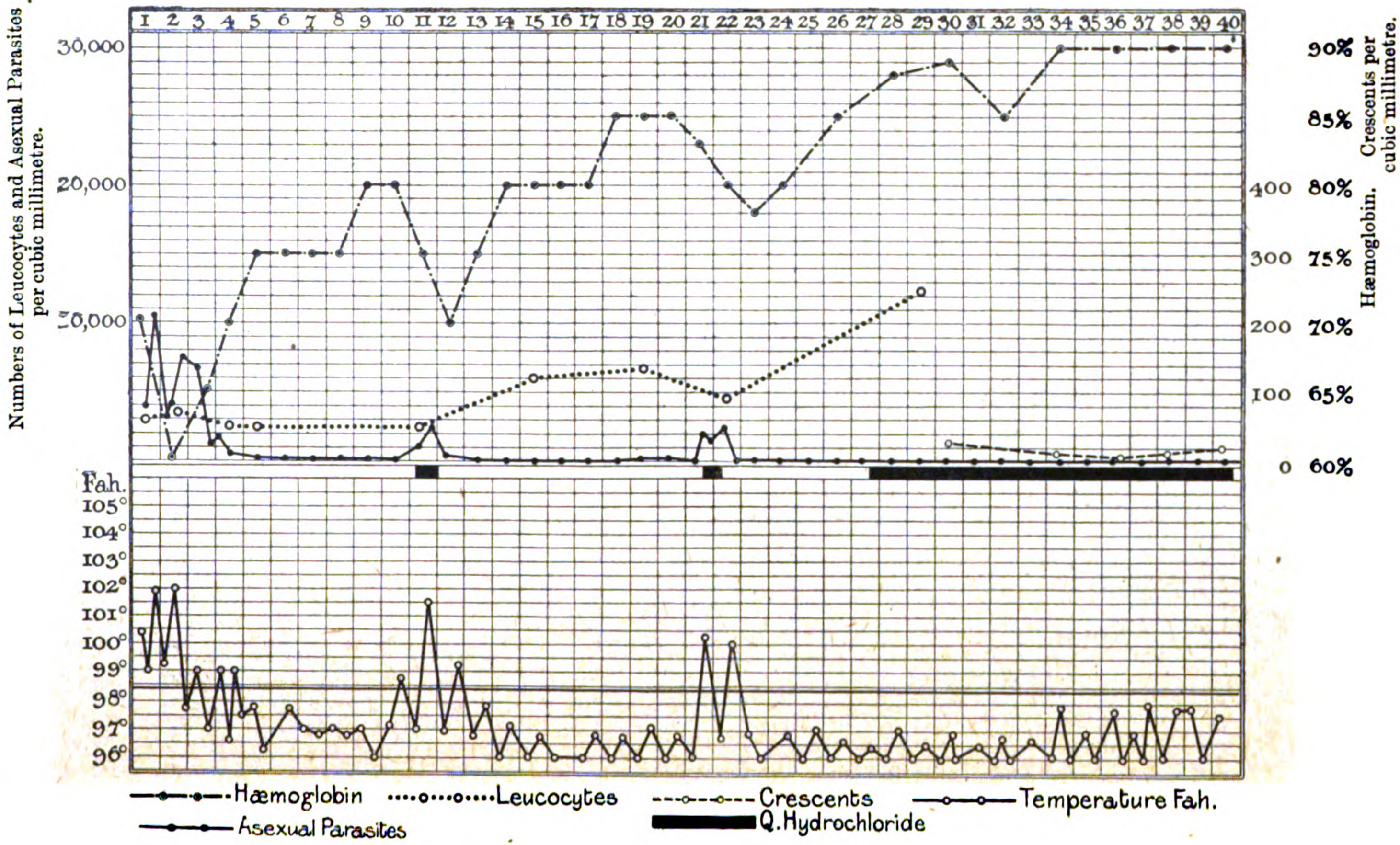
Normally the large mononuclears vary from one per cent to three per cent of the total leucocytes—Beattie and Dickson (1909). Stephens and Christophers (1908) consider a value of this variety of leucocytes above 15 per cent as diagnostic of malaria.

(5) The Course of the Disease without Quinine Treatment.

Without such a wonderful specific remedy as quinine, malaria would be a very trying and often a very fatal disease. The paroxysms would continue more or less regularly in many cases for weeks and even months. If reinfection were excluded, and death did not take place, in time the infection would gradually die out, more especially in strong healthy subjects. It is not a disease however in which a natural immunity is quickly developed. The patients in many cases would become extremely anæmic and cachectic with a large spleen, extending down to the umbilicus. The periods between the attacks would gradually lengthen, but for many years he would be liable to relapses, especially after exposure or fatigue. Patients indeed who have even been treated intermittently with insufficient doses of quinine often give such history.

Chart 9.

R.B. *P. falciparum.*



In many cases, however, the effect of rest in bed without any quinine treatment is quite remarkable. Several of our patients were admitted to hospital with quite a severe paroxysm of fever. They were kept in bed and given no treatment, except perhaps an aperient, yet in these cases the parasites would apparently disappear from the blood (they could, however, be detected as a rule in thick films) and the disease became latent. Sooner or later, however, a relapse would occur, perhaps after a week or ten days or longer (*vide* Chart 9).

Relapses in such cases could usually be brought on at will by allowing the patients to get up, or better still by allowing them to go out of hospital for a day. Such untreated cases eventually become more or less chronic and latent cases. They very often develop large numbers of gametes (sexual form of the parasite) and so become malarial carriers, since they are capable of infecting mosquitoes, thereby spreading the disease. It should be remembered that the asexual or fever-producing forms of the parasite do not infect mosquitoes, so the latent cases are as a rule much more dangerous to the community than the acute cases. It is well known also that the untreated or imperfectly treated cases which are continually saturated with the disease and go on relapsing at frequent intervals for years, are those which are most liable to develop attacks of blackwater fever.

(6) The Course of the Disease with Insufficient Quinine Treatment.

The course of malaria where insufficient quinine treatment is given resembles in a mild way the course of the disease without any treatment, except that there are fewer paroxysms of fever and longer intervals of latency, with a normal temperature. If the treatment is intermittent, relapses are almost certain to occur, even though the occasional doses of quinine given are large.

(*a*) *The Effect of Isolated Doses of Ten to Twenty Grains of Quinine.*—This is very well illustrated in Charts 9 and 10.

In Chart 9 it will be noted that the patient suffering from malignant tertian malaria was admitted to hospital in a febrile condition with parasites amounting to 10,000 per cubic millimetre of blood. He was put to bed but given no treatment. After four days his temperature became normal and the parasites had diminished in number to 288 per cubic millimetre, and on the eighth day to thirty-six per cubic millimetre. During this latent

period the number of parasites were so small that they could only be detected by the thick film method. On the eleventh day, however, they had again increased to 1,750 per cubic millimetre, accompanied with a rise of temperature of 101·5° F., thereby constituting a relapse. Twenty grains of quinine in solution were given that day by the mouth, and two days later no parasites could be detected in the blood even in thick films. On the fourteenth day, however, they were again detected. On the nineteenth and twentieth day, it was observed that they were increasing in number, and on the twenty-first day they had increased to 1,325 per cubic millimetre, accompanied with another relapse, the temperature rising to 100·4° F. Twenty grains of quinine were given once more with the same result. On the twenty-seventh day, he was put on a full course of thirty grains of quinine daily for three weeks. Other points of interest in the chart are the leucopenia during the fever and also the fall in the hæmoglobin percentage with each attack of fever. Note also the appearance of crescents nine days after the second relapse.

Chart 10 is another very interesting case, showing almost exactly similar results. Here two doses of quinine, one fifteen grains and the next twenty grains, caused the disease to remain latent for fourteen days. The parasites were, however, detected several times by thick film during that latent period. It must be remembered, however, that most patients do not escape so easily after such isolated doses of quinine. On the other hand, in some rare cases such single doses might prevent a relapse for several months, as some people seem to have much more natural resistance to the disease than others. In this chart it will be observed that the hæmoglobin fell during the relapse from seventy-eight per cent to fifty-two per cent. in three days. Under efficient quinine treatment, however, it rose again to ninety per cent in twelve days.

(*b*) *The Effect of Five Grains of Quinine given daily by Mouth in Solution.*—This treatment was powerless to prevent a severe relapse after twelve days as is clearly shown in Chart 11. This case was more or less chronic and latent. It should be noted how the crescents (gametes) increased in number during this treatment. Five grains of quinine given daily might keep the disease latent for a much longer period than was the case in this patient, but can it be considered of any value as a curative treatment? It should be considered rather as a dangerous mode of treatment, since there can be little doubt that quinine given in such small doses tends to increase the formation of gametes, thereby producing malarial carriers. We have noticed this result in several cases.

Chart 10.

F.B. *P. falciparum.*

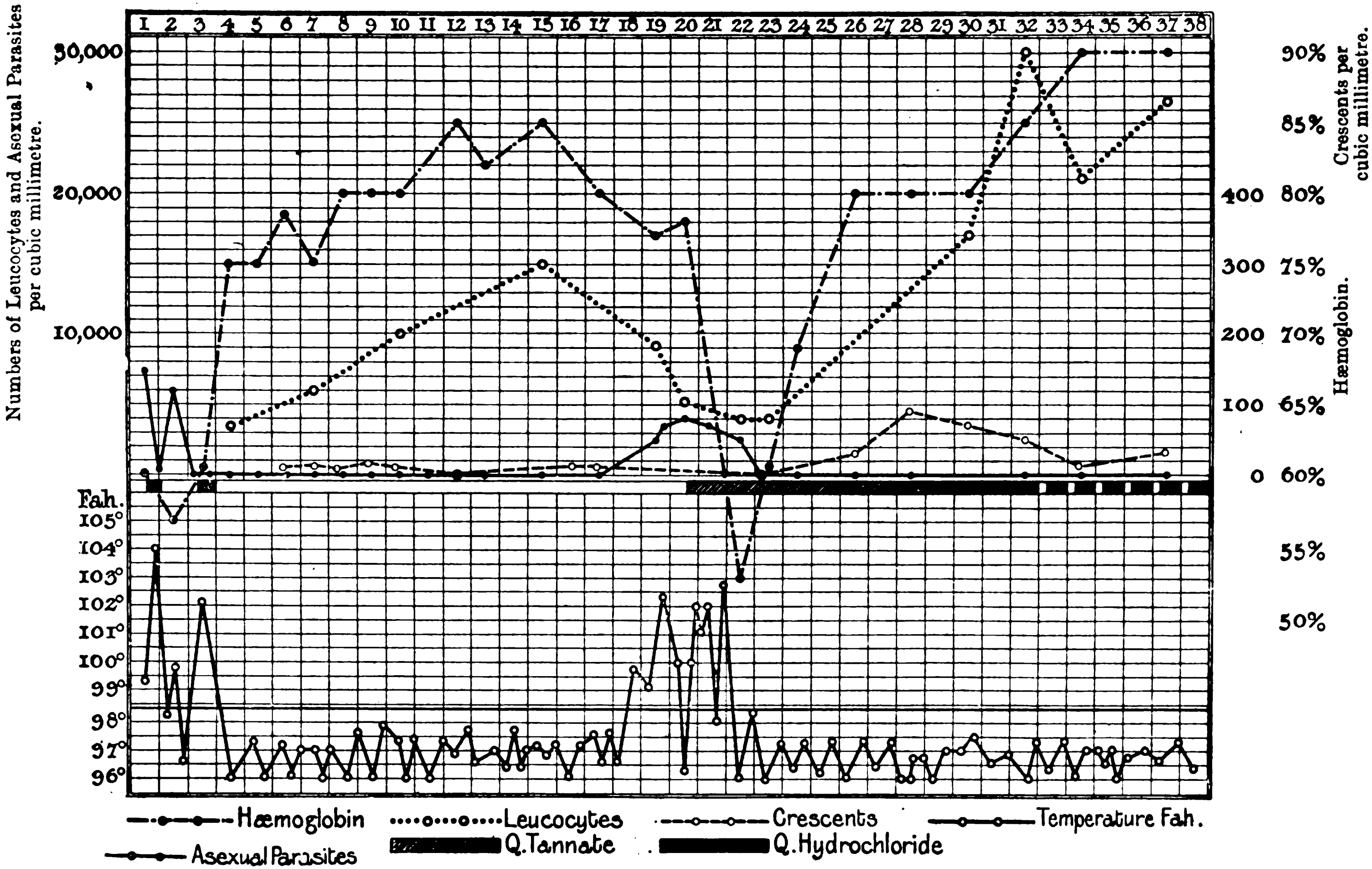
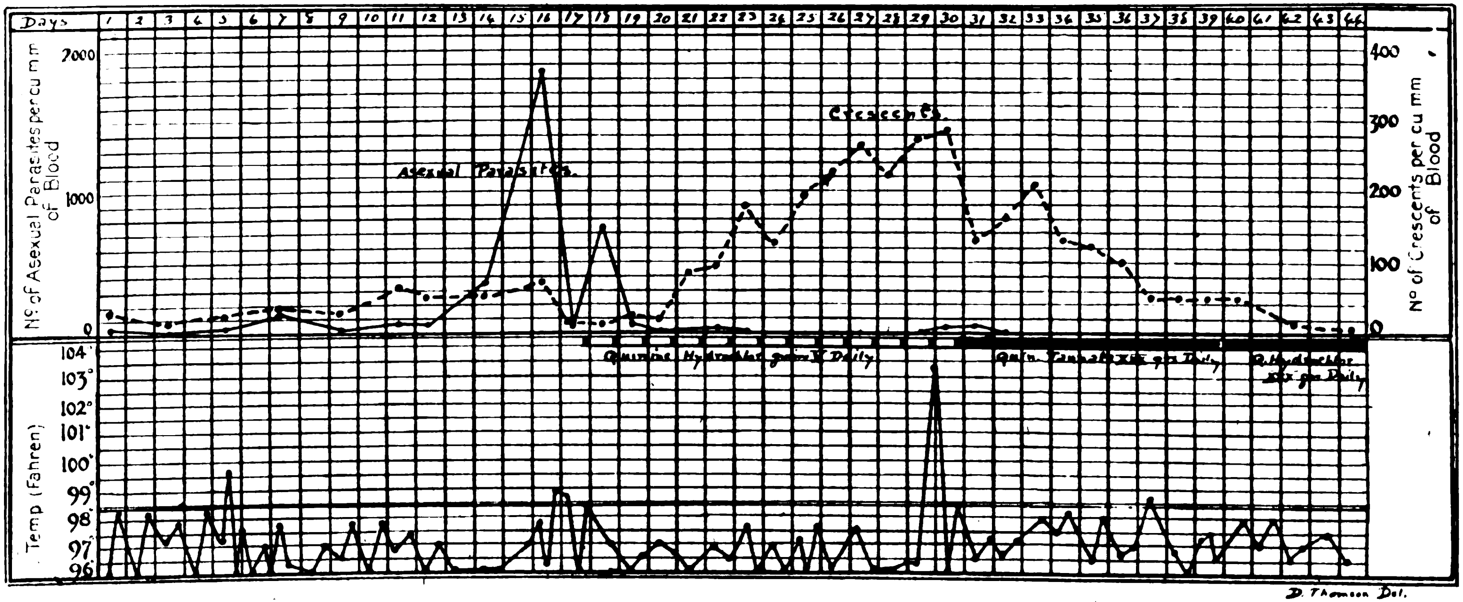


CHART 11.

A C. Case 18. (P. falciparum.)



(*c*) *The Effect of Full Doses of Quinine, Thirty Grains daily in Solution by Mouth, for an insufficient Period (seven to ten Days).*—Chart 12 provides an interesting demonstration of the amount of quinine that it is necessary to give in order to prevent relapses or, in other words, in order to cure the disease. This patient, T. C., was admitted to hospital with a severe attack of malignant tertian malaria, the asexual parasites amounting to 50,000 per cubic millimetre of blood. One dose of twenty grains of quinine was administered by mouth and the temperature fell to normal on the fourth day.

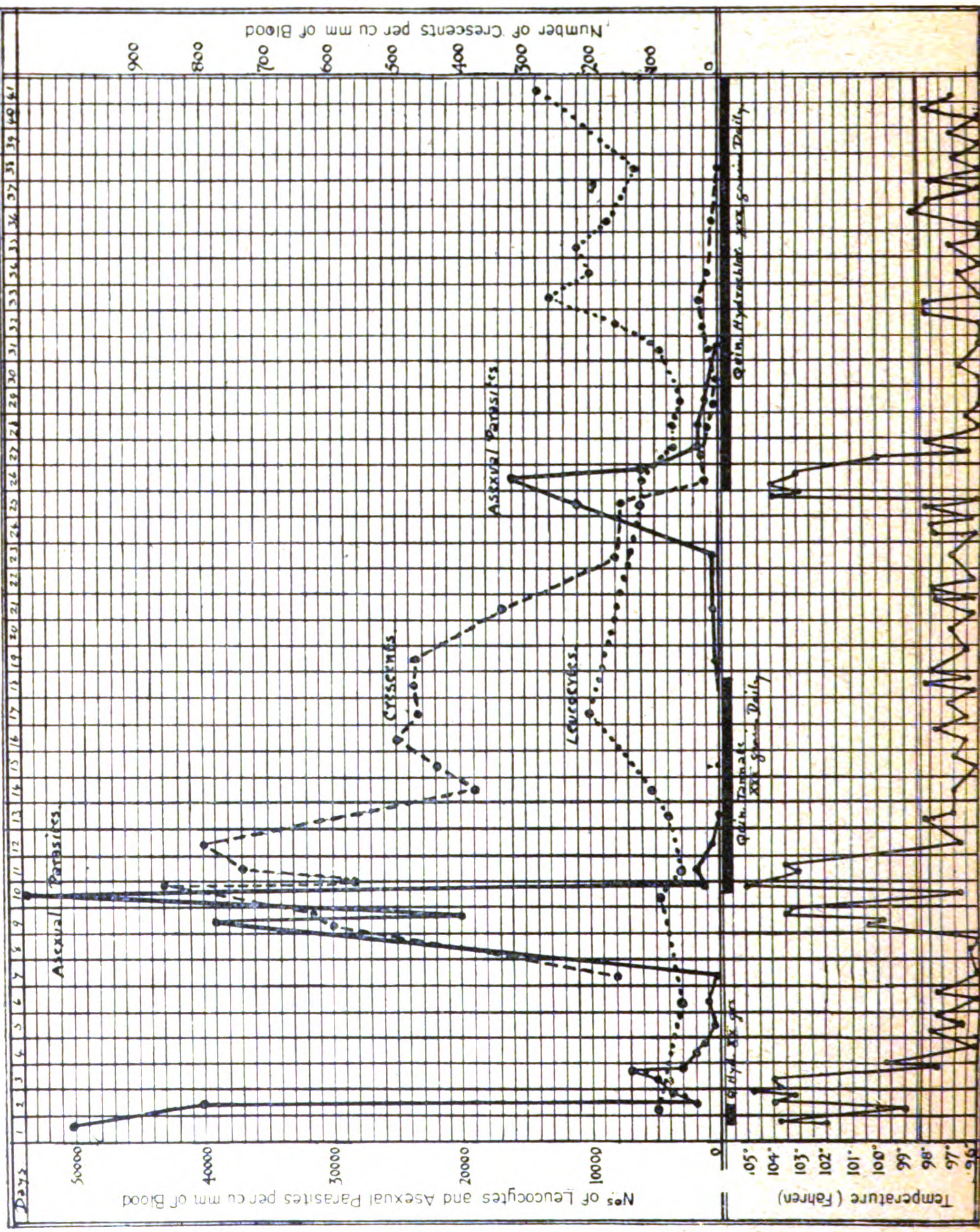
The number of parasites also diminished very markedly but they did not disappear.

On the eighth day they began to increase in number very rapidly, and by the tenth day they had risen to 55,000 per cubic millimetre. This marked increase was coincident with a severe relapse, the temperature rising to 105° F. Quinine was now given by mouth in doses of ten grains three times daily for a period of eight days. After three days of this treatment the asexual parasites completely disappeared. The quinine was stopped on the eighteenth day, and on the nineteenth day the parasites were found in small numbers. They began to increase gradually in number once again, however, until on the twenty-fifth and twenty-sixth days they amounted to 10,000 and 16,000 per cubic millimetre. This rise was synchronous with another relapse as shown on the chart. Quinine was now given in doses of ten grains three times daily for a period of three weeks and no further relapse occurred. Cases of this kind demonstrate most clearly the need of continuous and heroic quinine treatment, and it is only by studying the disease scientifically in this manner that one can eventually arrive at a correct conclusion with regard to the minimum treatment that is necessary to bring about a cure. If the quinine is given early and in large enough doses for a sufficient period of time, the disease is likely to be cured. On the other hand, except in unusual circumstances, it is certainly malpractice to give thirty grains daily for a few days, or even for ten days, and then to discontinue. Quinine given in such an intermittent fashion is often quinine wasted. If we let the parasites recover after a bad "knock-out" with a week's treatment, then it means that to give the final death blow we have just to start all over again. Thirty grains of quinine for three weeks makes in all 630 grains. This may cure the disease once and for all when given early.

There are many patients, however, who have suffered from malaria for years, often because they will not submit to this

CHART 12.

T C Case 23 (P.falciparum)



treatment, or because the physician does not think it is necessary. If the amount of quinine taken by such patients intermittently was added up, it would, in many cases, amount to thousands of grains and yet no final cure is obtained. Furthermore, we have good reason to believe that such intermittent treatment gradually renders the parasite to some degree quinine resistant, so that the cure becomes all the more difficult in the end. Thus early cases are more easy to cure than long-standing cases which have been badly or intermittently treated from the commencement (*vide* James, 1913).

In order to emphasize still further that intermittent quinine treatment is malpractice, I would like to refer again to Chart 12. It is clearly noticeable that the number of crescents remained very high during the imperfect quinine treatment, and that they continued to be found in the blood until the thirty-eighth day after the admission of the patient. Had this case received the continuous course of quinine from the first day of admission, the crescents would certainly have been reduced to one per cubic millimetre by the nineteenth or twentieth day at the latest.

Since the crescents or gametes (sexual parasites) are the agents which infect mosquitoes, thereby propagating and spreading the disease, it is of extreme importance to rid the blood of them. Small doses of quinine encourage their production and intermittent large doses have the same effect. I hold, therefore, that except in unusual circumstances clinicians who adhere to treatment in small doses, or who give large doses (thirty grains daily) intermittently are doubly guilty of malpractice, and that patients who refuse to undergo a thorough course of treatment are not only foolish to themselves, but are in addition a danger to a tropical community infested with mosquitoes.

The minimum amount of quinine necessary to rid the blood of gametes will be dealt with under paragraph 13.

(7) The Cause of the Relapses.

In his able paper on "The Etiology of Relapse in Malarial Fever," James (1913), makes the following statements:—

(1) "To-day, as in the past, relapse is a very common feature of malarial infection.

(2) "Relapse almost invariably follows the so-called spontaneous cure of primary cases of malaria, that is, the cessation of symptoms without treatment.

(3) "Infections treated insufficiently with small doses of quinine will in all probability relapse.

(4) "The sooner prompt and vigorous treatment is instituted after the onset of the primary attack the less likely is relapse to follow; and conversely, the later the primary attack is treated, even with large doses of quinine and for a long time, the more certainly will the symptoms recur.

(5) "Sometimes a relapse, with parasites in the peripheral blood, will take place, although the patient has not stopped taking quinine. These cases are rare, but I have noted several in Ancon Hospital.

(6) "If reinfection is excluded, and death does not take place during a relapse, in time the infection will die out, otherwise there would be no immunity, and every untreated case would end in death. This applies in the last analysis even to persons who are "carriers," and who manifest no febrile symptoms, although parasites may be found in the peripheral blood.

(7) "It is easier to effect a permanent cure for persons in good health prior to the attack than for those in whom the malaria infection is complicated by bodily weakness or intercurrent disease, especially syphilis."

James believes that the parasites develop more or less rapidly some resistance to quinine if they are not killed outright by a proper and sufficient treatment with the drug. It has been stated also by Mannaberg (1894) that it is difficult to attack the parasites in the parenchyma of the spleen and marrow with quinine. James expresses the same belief. He found that cases dying from malaria after three or four days of vigorous treatment very often showed a few parasites in autopsy smears of the spleen and bone marrow; they could not be found, however, in smears of the peripheral blood, in spite of the fact that the latter contained many more red cells per microscopic field than the smears of the former. He also found in cases which died after three to five days' quinine treatment, that the parasites were observed more frequently in the spleen and marrow in those to whom the quinine had been given orally, less frequently where hypodermic injections had been given, and least frequently where three or four doses of 22·5 grains of quinine had been given intravenously. He believes that the parasites in the spleen and marrow escape the full effects of the quinine, so that even when those in the peripheral circulation are killed a residuum of parasites remains in these organs. When these have multiplied beyond a certain extent, they find their way into the peripheral blood and with further muliplication they cause a febrile relapse. He believes also that quinine given intravenously is the best mode of getting at these residual parasites in the spleen and bone marrow,

so that fewer relapses occur when the drug is administered in this way. He describes in some detail a very persistent relapsing case of malignant tertian, with severe cachexia, which occurred in the Philippine Islands General Hospital under the care of Dr. D. M. Molloy. In this case both oral and hypodermic administration of quinine failed, but a very rapid and marvellous recovery took place with a course of intravenous treatment (*vide infra*).

It would appear that the most sensible way of explaining relapses is to assume that the asexual parasites have not all been killed, due to an insufficient course of quinine. The number of asexual parasites may, however, be reduced so much that they are almost impossible to detect even in thick films. They have been reduced to numbers no longer detectable, yet they are nevertheless present, and when quinine is withheld they begin to multiply again very rapidly. As soon as the number has again increased sufficiently to cause fever then we have a relapse. There is, however, another school of thought which holds forth a different hypothesis to explain these relapses. This hypothesis, originated by Schaudinn, is based upon the belief that the sexual forms or gametes are capable of parthenogenesis, that is to say, they are capable of breaking up into asexual or fever-producing parasites. The gametes are quite resistant to quinine, so when all the asexual forms are killed off the former remain, and by transforming themselves into new asexual parasites they give the disease a new lease of life. Several competent workers (Schaudinn, Craig, Harrison, etc.), claim to have witnessed the transformation of gametes into asexual parasites (parthenogenesis); but, on the other hand, the majority of experts have never seen this phenomenon. There is no definite proof that it really does occur. Further research and confirmation is still necessary. Relapses are found to occur in cases which show no gametes in the blood as well as in cases where these are present. This alone is strong evidence against the parthenogenesis hypothesis. In any case such a hypothesis is unnecessary, since we know that no single disease is easily cured even by a very specific drug. In syphilis the spirochætes may disappear rapidly under 606 treatment, and the Wassermann reaction may even become negative, yet on stopping treatment both may again return. There is no need, however, to try to account for this by some unproved hypothesis. It seems sound enough to assume that the treatment simply did not kill every spirochæte, and that the few which did survive brought about a new relapse by further multiplication.

(*To be continued.*)

AN INQUIRY INTO SOME PROBLEMS AFFECTING THE SPREAD AND INCIDENCE OF INTESTINAL PROTOZOAL INFECTIONS OF BRITISH TROOPS AND NATIVES IN EGYPT, WITH SPECIAL REFERENCE TO THE CARRIER QUESTION, DIAGNOSIS AND TREATMENT OF AMŒBIC DYSENTERY, AND AN ACCOUNT OF THREE NEW HUMAN INTESTINAL PROTOZOA.

[*Conducted under the auspices of the Medical Advisory Committee, M.E.F.* (*January to August*, 1916).]

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(*Continued from p.* 565.)

CONTENTS.

Part IV.

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Experimental Work with the Human Intestinal Protozoa, their Carriage by House-flies and the Resistance of their Cysts to Disinfectant and other Agents.

(1) *Experimental Work.*

A number of experiments were conducted with cats, rats and mice with a view to infecting them with intestinal protozoa. Most of these gave negative results but are none the less interesting. The following is a record of these.

(1) *E. histolytica.*—An attempt was made to infect two kittens by means of flies which had fed on fæces containing *E. histolytica* cysts. Batches of flies were allowed to feed on fæces and then placed over bread and milk on which they deposited fæces very plentifully. The kittens were then fed on the bread and milk. This was repeated daily for six days after which the kittens were carefully observed. Between three and four weeks later the kittens became ill and a couple of days after passed typical dysenteric stools with blood and mucus. Examination of this microscopically showed numerous cells of all kinds but no amœbæ. The kittens recovered and one was killed ten days later. There were no lesions of the gut and no amœbæ were found. The nature of the dysenteric attack was thus undetermined.

(2) Two cats were anæsthetized and inoculated intrahepatically with about two to three cubic centimetres of liver abscess pus containing numerous active *E. histolytica*. One cat escaped but continued for some weeks to wander about the hospital grounds. It remained perfectly well and active enough to avoid capture. The other cat remained well for some time, but twenty-six days after the inoculation it became ill and lethargic. The next day as it was worse it was chloroformed. No lesions of any kind were discovered and there was no mark of the inoculation, though there was no doubt whatever that this had actually been made into the liver.

(3) A kitten was inoculated *per rectum* with about ten cubic centimetres of liver abscess pus containing active *E. histolytica*. As nothing happened, a week later the injection was repeated. No dysentery developed and no infection occurred.

(4) A young kitten was given about five cubic centimetres of fæces emulsion of case Carr with large infection of *E. histolytica* cysts. Case Carr had never suffered from dysentery. The emulsion was administered by pouring it into the kitten's mouth. The kitten with the mouth still soiled was placed in a cage with another kitten. A week later both kittens became ill with acute dysentery, from which they died. There were numerous *E. histolytica* in the blood and mucus stools and extensive ulceration of the large intestines. The experiment is of interest in showing that cysts from a carrier who had no dysentery could produce acute dysentery in cats. The second kitten must have been infected by licking cysts from the soiled mouth of the first cat.

(5) A kitten was given *per os* on two occasions emulsion of fæces of case Healy. There was a history of repeated attacks

of dysentery and numerous cysts and minute forms of *E. histolytica* were present. The kitten did not become infected. In this instance, though there was a definite dysentery history, no infection of the kitten took place (compare Experiment 4).

(6) A kitten was given on two occasions *per os* emulsion of fæces of case Smith, who constantly suffered from amœbic dysentery, there being present in the stool active amœbæ, many of which contained red blood corpuscles. Cysts of *E. histolytica* were never found in this case during a long observation (see above). The kitten did not develop dysentery and did not become infected.

(7) Two white rats were fed on two successive days with fæces emulsion containing numerous *E. histolytica* cysts. The rats did not become infected and showed no signs of illness during an observation of over two months.

(8) A mouse was fed on several occasions with fæces of case Healy containing numerous *E. histolytica* cysts. No infection and no sign of illness was noted in an observation of over three months.

Tetramitus Mesnili.—(1) A large quantity of emulsion of fæces containing numerous free and encysted tetramitus was introduced into the stomach of a kitten by means of a stomach tube. The kitten never showed any tetramitus infection.

(2) A mouse was fed on the same material but no infection occurred.

(3) A rat was similarly treated and likewise did not become infected.

Coccidia (*Isospora*).—(1) A kitten was fed on several occasions with developed oöcysts of the human isospora. No infection took place. An isospora is found very commonly in Alexandria cats, but the oöcyst is quite unlike that of the human parasite. The oöcysts of the cat isospora resemble those of the European form.

(2) A mouse was fed repeatedly with developed oöcysts and no infection took place during an observation of over four months.

Observations on Lizards.—A number of lizards which lived in open spaces in Alexandria were examined. Two distinct types were dissected. One of these (Agama sp.?) is very common in stony places, where it lives on flies and also appears to feed upon vegetable material. In this amongst other protozoa were found a tetramitus and an amœba which resembled *E. coli* not only in its free stage but also in the production of an eight-nuclear cyst indistinguishable from that of *E. coli.* The other lizard was a skink which lived in sandy places. It fed exclusively on insects. There were numerous flagellates in the gut but none resembling

those of the human intestine. It seems just possible that lizards might become infected with human parasites by feeding on flies which had already fed on human fæces.

(2) *Flies as Carriers of Intestinal Protozoa and other Infections.*

The relation of house-flies to the human intestinal protozoa and the possibility of their dissemination by flies which have fed on infected fæces has been discussed by us in two earlier publications. (Memorandum on the carriage of cysts of *E. histolytica* by house-flies, with some notes on their resistance to disinfectants and other agents, issued by the Medical Advisory Committee, Mediterranean Area, April, 1916, and the same with additional notes on a more extended examination of wild flies, in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, May, 1917.)

We have shown that flies which feed on fæces containing the free or encysted protozoa readily take these into their intestine. By dissecting flies at various intervals after feeding we have noted that so long as any of the fæces remained in the gut the encysted forms could be found.

The following is a record of some of our observations. In these nothing of a doubtful nature has been accepted as evidence of the presence of a cyst of one of the intestinal protozoa. We have carefully ignored anything which was not absolutely certain, so that our finds in the examination of wild flies are somewhat lower than was actually the case.

(*A*) *Flies fed on Infected Fæces and Dissected later.*—(1) Six flies were enclosed under a glass with fæces of case Ure which contained a fair number of cysts of *E. histolytica* and a leptothrix. The flies were dissected twenty hours after the fæces had been removed. The stomachs of all the flies contained fæces in which cysts of *E. histolytica* occurred as well as the leptothrix which was present in the stool. The loaded rectum of one fly was cut off and examined separately. A few cysts of *E. histolytica* were seen. Some of the cysts appeared quite normal and did not stain with eosin, others appeared to be degenerate. In our previous publications we have shown that cysts which do not stain with eosin are probably alive.

(2) The same experiment was repeated with fæces from the same case two days later with three flies. Dissected eighteen hours after feeding, all three flies showed fæces in the gut, in which the leptothrix was present but nothing definitely diagnosable as cysts of *E. histolytica* were found.

(3) Twelve flies were allowed to feed on fæces of case Turner containing a fair number of cysts of *E. histolytica.* Dissected eighteen hours after feeding the flies gave the following results. (*a*) One fly had a fairly full gut and in the contents four undoubted cysts were found. (*b*) Six flies had practically no fæces in the gut and no cysts were discovered. (*c*) Five flies had absolutely empty guts and no cysts were found.

(4) Eight flies were fed on fæces of case McCaffrey which contained a large number of cysts of *E. coli* and a small number of cysts of *E. histolytica.* The flies were dissected twenty-four hours after feeding with the following results. (*a*) Four flies had empty guts and no cysts were found. (*b*) Two flies had a little fæces in the gut and eight nuclear cysts of *E. coli* were found. (*c*) One fly had a good quantity of fæces in the gut, a fair number of cysts of *E. coli* were present and one cyst of *E. histolytica* was seen. The cyst did not stain with eosin. (*d*) One fly had a good quantity of fæces in the gut and numerous cysts of *E. coli* which did not stain with eosin.

(5) Three flies were fed on stool of case McCaffrey and were dissected forty-two hours after feeding. (*a*) One fly had a fair amount of fæces in the gut and a corresponding number of *E. coli* cysts which did not stain with eosin. (*b*) Two flies had empty guts and no cysts were found.

(6) Three flies were fed on stool of case McCaffrey and were dissected seventy hours after feeding. The gut was empty in all three flies and no cysts were discovered.

(7) Nine flies were fed on fæces of case Hancock with large number of cysts of *E. histolytica* present. The flies were dissected forty-two hours after feeding. In every case the gut was empty and no cysts were discovered.

(8) Eight flies were fed on fæces of case Badham which contained large numbers of cysts of *Lamblia intestinalis.* The flies were dissected twenty-four hours after feeding with the following results. (*a*) One fly had no fæces in the gut and no cysts were found. (*b*) Two flies had very little fæces and no cysts were found. (*c*) Five flies had a good amount of fæces in gut and numerous lamblia cysts were present. With eosin some stained and others did not.

From the foregoing records of feeding experiments it is clear that flies readily take up cysts when they feed on fæces, and that these cysts remain in the gut so long as fæces remain there. The flies, however, get rid of the fæces in twenty-four hours, after which

cysts can no longer be found. In the experiments recorded above the flies were given no food after having fed on the fæces. It is probable that the fæces would be more quickly got rid of if the flies were feeding constantly as they do in nature. Further, the cysts do not degenerate to any extent, at any rate the length of time the cysts would remain in the gut under natural conditions would not be enough to bring about their destruction.

(*B*) *Flies fed on Infected Fæces and their Fæcal Droppings examined later.*—(1) One fly was allowed to feed on fæces of case Hancock with large infection of *E. histolytica* cysts. Half an hour later six dried fæcal deposits were taken up in eosine saline solution. There were present a fair number of cysts of *E. histolytica*, all of which were stained. A further number of droppings were taken up two hours later with a similar result.

(2) Four flies were allowed to feed as above. Two hours after the fæces had been removed the flies were given fresh fæces on which to feed. Soon after feeding some moist fæcal droppings were taken up in eosine saline. There were present fair numbers of cysts of *E. histolytica* which did not stain with eosine.

(3) Six flies were fed on fæces of case Hancock with large infection of cysts of *E. histolytica*. Sixteen hours after the removal of the fæces the flies were given sugar and water on which to feed. The droppings which were deposited soon after were taken up while still moist in eosine saline solution. There were present fair numbers of cysts of *E. histolytica* which did not stain with eosine.

(4) Six flies were fed on fæces of case Hancock with large infection of cysts of *E. histolytica*. Moist droppings of the flies were examined twenty and thirty minutes later, and cysts of *E. histolytica* were easily found in both examinations.

(5) Six flies were allowed to feed on fæces containing a mixed infection of *E. coli* and lamblia cysts. Moist droppings deposited forty minutes later contained cysts of *E. coli* and lamblia.

(6) Experiments of the same nature were conducted with *Calliphora* sp. and *Sarcophaga* sp., with similar results.

(7) Six house-flies were allowed to feed on liquid fæces containing active trichomonas. Moist droplets were passed within five minutes of feeding, and these contained living unaltered trichomonas.

(8) A small batch of flies were allowed to feed on the fæces of a case containing cysts of lamblia (numerous), and *E. histolytica* (few); after five hours the dried droppings of these flies were examined. Numerous lamblia cysts were found, and in addition a cestode egg (forty by forty-eight microns), and an operculated trematode egg (twenty microns).

These flies had been caught near the laboratory where a cat was kept, which was known to be passing similar cestode and trematode eggs in the fæces.

The above experiments were conducted with ordinary wild flies. They were placed in glass globes covered with mosquito netting, and were allowed to starve for a few hours before the fæces were offered to them. This was done by placing a small quantity on a cover-glass and sliding it under the jar. When the flies had fed it was removed. To obtain the droppings before they dry it is necessary to watch the flies carefully as the droppings dry very quickly, especially in a hot country where the observations were made. A long drawn-out capillary pipette is used and some saline is run into the fine capillary end of this. So soon as a fly is seen to deposit a dropping a tiny drop of saline is blown on to it and it is then touched with the capillary end of the pipette, when it will run up into the capillary tube. As much of the contents of the capillary tube as is necessary is then blown on to a slide and examined under a cover-glass. If there is any doubt iodine solution can be added.

This method of examination of moist droppings is very useful for the control of the passage of infectious material through flies, and it could very readily be adapted for bacterial work in connexion with the passage of typhoid, dysentery and other bacteria through the flies' intestine.

(*C*) *Examination of Wild Flies taken in various Localities.*—The main result of our examination of wild flies has already been given in another place (JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, May, 1917), but some further explanation of the methods employed will be given here together with some additional observations.

The majority of the flies were examined singly, though some were examined in batches. When examined singly, the fly was caught in a glass tube (2 by 1 inches), and the tube was placed on the laboratory bench standing with the open end on a glass slide. No food was given to the fly, which deposited droppings either on the sides of the tube or on the slide. The total number of the droppings deposited by the fly, the number of droppings on the slide, and the length of time since capture were noted. Only the droppings on the slide were examined. In most cases these were dry when examined, but the drying did not interfere seriously with the identification of the objects present. The examination was carried out by running some saline solution on to the slide, and

placing over the droppings a cover glass. The droppings were then examined with the $\frac{2}{3}$ and $\frac{1}{6}$-inch objective without disturbing them. A gentle tap on the cover glass then caused the droppings to spread out slightly, when such objects as worms' eggs could be detected. From one large dropping there emerged in this manner two lateral-spined bilharzia eggs. Finally, the cover glass was moved, so that the droppings were completely emulsified in the saline, and search was made with the $\frac{1}{6}$ and $\frac{1}{12}$-inch objectives for cysts of protozoa and other objects. It is evident that any eggs or cysts discovered in this manner must have passed through the intestine of the fly. The view that any of the cysts or eggs found had been transported on the legs of the flies is hardly tenable. As far as the worms' eggs are concerned, these were always found in the droppings themselves before they had been completely emulsified in the saline—and this was true most usually of the cysts also—so there is very little likelihood that any of the objects found had been deposited by the flies' legs on the slide between the droppings.

As already stated, doubtful objects were ignored, and, for the identification of the cysts, iodine solution was often used by drawing it under the cover glass by means of blotting paper.

We have given our method of examination in some detail, because some other observers who have examined flies have relied upon dissection of the gut, and quite recently Shircore, who has examined flies for worms' eggs in Mombassa hospital, employed a method which involved emulsifying the organs of the flies, and centrifuging after addition of ether. The examination of droppings as we have done affords a very simple method for detecting to what extent flies in any locality are infecting themselves through having access to fæces. Further, it is indirectly an indication of the efficiency of the sanitary arrangements in any neighbourhood where human beings are infected with organisms which can be recognized microscopically in the stool.

It is impossible to give a complete record of all the flies examined with the number of droppings passed by them, and the time occupied. This will be done only for the flies which were found to be positive by way of illustrating the records which have been kept. (See table.)

All the above flies were caught in the hospital compound, and many of them in the neighbourhood of, or actually inside, the cook-house, which was built against a wall separating the hospital compound from a native village. This village was in a filthy condition, and the natives were constantly depositing fæces along the

front of this wall. It seems clear that the flies must have become infected in the village on the other side of the wall.

TABLE SHOWING RESULTS OF EXAMINATION OF 18 POSITIVE FLIES OUT OF A TOTAL OF 229.

Number	Total droppings	Droppings examined	Time	Result
1	9	9	8 hrs.	One cestode egg with six-hooked embryo μ 40; one trematode operculated egg μ 30; (probably *Heterophyes* heterophyes).
3	13	13	8 ,,	E.c.c. (several cysts)
9	20	3	6 ,,	E.c.c. (several cysts), E.h.c. (one cyst)
29	7	2	10 ,,	Two lateral spined Bilharzia ova 130 × 50μ (in one dropping)
38	4	4	4 ,,	E.c.c. (one cyst), E.h.c. (one cyst) and ovum of *Trichocephalus trichiurus.*
51	6	3	4 ,,	Trematode ovum μ 35 × 20.
84	2	2	15 mins.	E.c.c. (one cyst)
109	2	2	4 hrs.	E.h.c. (one cyst)
144	4	4	20 mins.	*Tænia saginata* egg.
135	5	3	2 hrs.	Coccidium oöcyst μ 28 × 20 (Eimeria).
142	2	2	10 mins.	Lamblia cysts in great numbers, 36 in one dropping.
150	2	2	1 hour	Possibly nematode egg μ 44 × 20.
151	1	1	2 hrs.	E.c.c. (one cyst)
153	2	2	2 ,,	E.h.c. (one cyst)
155	4	4	2 ,,	E.c.c. (several cysts), and three ankylostome ova.
167	3	2	3 ,,	Possibly nematode eggs μ 40 × 20.
194	7	5	3 ,,	Egg of *Trichocephalus trichiurus.*
216	7	4	7 ,,	E.h.c. (one cyst).

In this manner there were examined in all 229 flies, with the results given in the above table.

In addition to the examination of single flies, a number of flies were examined in batches, the collective droppings of each batch being examined without any reference to which fly of the batch had deposited the dropping. Nine batches of 6, 8, 3, 5, 3, 3, 2, 2, 4, flies were examined in this way, with the result that a single ankylostome egg (60 by 40 microns) was found in a dropping of the first batch of flies.

Two calliphora, two sarcophaga, and one lucilia deposited seven droppings in an average of three hours and a half. Nothing was found in the droppings.

As regards the 229 flies which were examined singly, the total number of droppings deposited by these was 1,470, of which 608 were examined. The average time each fly remained in the tube before the droppings were examined was four hours and a half. The average number of droppings of each fly is between six and

seven in this interval of time. In another experiment with wild flies twelve were enclosed in a box made of glass slides. During the first twenty-four hours after capture the flies deposited in all 283 droppings, given an average of 23·5 for each fly. The flies were given no food after capture.

(*D*) *Quantity of Fæces taken up by Flies.*—An attempt was made to obtain some indication of the quantity of fæces taken up by a fly in a limited period of time. To this end a series of weighing experiments were carried out in the following manner. Small quantities of fæces were placed in cover glasses, and these were weighed. Two cover glasses of approximately the same weight were used in each observation. They were weighed the one immediately after the other, and were then placed under two glass globes, in one of which were one or more flies which had been without food for two or three hours. After half an hour's exposure to the flies, the cover glass was again weighed, and the loss in weight noted. The control cover glass in the second globe without flies was then weighed, and the loss in weight by evaporation deducted from the loss in weight of the first cover glass. It was assumed that as the weight of cover glass and fæces was approximately the same in the two cases, the loss by evaporation would be the same, or nearly so.

As a result of seven experiments in which sixty-one house-flies were used the following figures representing weight in grammes were obtained for the quantity of fæces taken up by a single fly: 0·001, 0·0005, 0·0003, 0·001, 0·001, 0·0027, 0·0024. This gives an average of 0·001 grammes per fly. It may be assumed, therefore, that a single fly which has not fed for two or three hours can take up one milligram of fæces in half an hour.

General Considerations.

In our former communications we have emphasized the influence of the house-fly as a disseminator of infectious material. The experiments show how readily this is done, for a fly which is constantly feeding is constantly passing material through its gut, and this may be accomplished in five minutes as proved by the trichomonas experiment recorded above where the living flagellate was found in the droppings of the fly five minutes after feeding. It is quite evident that as the unprotected flagellate can pass safely through the intestine of the fly encysted stages of protozoa will do so much more easily. In fact one can safely assume that all such organisms, including bacteria, will in such a short time pass undamaged through the fly's intestine. This being

the case it seems that the fly is much more dangerous on account of material passed through its intestine directly than on account of material which it may regurgitate, or which has become adherent to its legs or body where it quickly dries, and is in most cases quickly destroyed. There is no question of any development in the gut of the fly, which acts merely as a distributor of infectious material. In warm countries there is great danger from this, for these flies abound, and there the insanitary native is in league with the flies, for by depositing his fæces indiscriminately in the open, he not only supplies infectious material for the flies to feed upon, but at the same time affords them a breeding ground wherein they can lay their eggs.

We have shown above by the record of our examination of natives in the Hadra prison and of a small number of human fæcal deposits collected in the open how common are protozoal infections amongst the natives, and it is not to be wondered at that we have found such a comparatively large number of infected flies, especially when it is remembered that these flies had probably been feeding previously in the native village. In these countries flies must be constantly taking up material and depositing it upon food, and it seems to us that the wide distribution of the intestinal protozoal infections amongst the natives can more readily be accounted for in this way than any other. It is probable also that other intestinal disorders are spread in a similar manner.

The observations recorded demonstrate the importance of all measures directed against the flies, their capture and destruction and the removal of every possible breeding place. It is perhaps of interest to record here the fact that one of the large fly traps designed by Lieutenant-Colonel Balfour, C.M.G., R.A.M.C., was put up in the hospital compound near the cook-house. It had a marked effect in reducing the number of flies which entered the cook-houses, and this can easily be understood when we realize that a catch of forty-eight hours yielded one and three-quarter pints of flies. A count was made and it was found that one pint of flies (mostly Musca, with an admixture of larger forms such as Calliphora, Lucilia, Sarcophaga, etc.), numbered a little over ten thousand. Furthermore, many of the flies recorded in the table above as being infected, were actually caught either inside or as they were about to enter the fly trap.

Conclusions regarding the Fly Question.

(1) Flies feeding on fæces readily take up encysted and other forms of protozoa into their intestine.

(2) The encysted forms of the protozoa can be found in the fly's intestine so long as any fæcal matter remains there. If the flies are prevented from feeding this may be as long as forty-two hours. If the flies are feeding constantly off various materials the later feeds tend to clear out what has been taken up before, so that the time becomes shorter.

(3) The cysts do not degenerate to any extent in the gut of the fly.

(4) Flies can deposit in their own droppings material they have ingested only five minutes before. Live trichomonas were found in the fæces of a fly which had only fed five minutes before.

(5) Cysts of protozoa (and eggs of worms) can readily pass unaltered through the intestine of the fly.

(6) Under natural conditions, if flies have access to infected fæcal material (cysts of protozoa or eggs of worms) a large percentage of the flies taken in the neighbourhood, as proved by the examination of their droppings, will be found to have the infectious material in the gut and a still larger proportion will be found to have fed on fæcal matter.

(7) Flies becoming infected in this way will naturally deposit the material on any kind of food on which they feed, and it seems that the wide distribution of human protozoal infections in warm countries can best be explained in this way.

(8) The direct passage of practically unaltered material through the gut of the fly would seem to be of more importance in the distribution of disease generally than the regurgitation of such material through the proboscis or its adherence to the legs or bodies of the flies.

(9) These observations all tend to emphasize the importance of the well-known sanitary measures directed against the fly, its destruction by traps and other means, the removal of its breeding places, the protection of food, kitchens and dining rooms and latrines from its inroads, and the removal of the dwellings of natives as far as possible from those of the Europeans.

(3) *Resistance of Cysts of E. histolytica and other Intestinal Protozoa.*

In our former publications we have described our experiments on the action of various reagents on cysts of *E. histolytica*. By way of making the present report complete, we will enumerate the chief conclusions here. We have explained that the eosin test as applied by Kuenen and Swellengrebel seems to be reliable. Cysts which

stain with eosin are dead and those which resist the stain are alive. This was the test we applied in determining the viability of cysts.

(1) Cysts of *E. histolytica* will survive for over a month in water provided there is great dilution of the fæces.

(2) Cysts of *E. histolytica* will not withstand drying but are killed instantaneously. The Thompsons have shown that the free-living *Amœba limax* produces a cyst which will withstand complete and prolonged desiccation under a tropical sun.

(3) Cysts of *E. histolytica* are killed at once if fæces containing them are mixed with an equal quantity of 1 in 10 cresol solution. Free chlorine in water to a strength of 1 in 10,000 has no effect on the cysts even after several hours' exposure.

(4) Cysts of other intestinal protozoa behave in a similar manner.

The inference is that the intestinal protozoa will spread from man to man only if the encysted stages remain moist, and this condition is fulfilled in fly and water carriage.

Summary of Matter discussed in Part IV.

(1) Attempts were made to infect rats, mice and kittens with *E. histolytica*, both in fæces and liver abscess pus. Two kittens alone became infected.

(2) *Tetramitmus mesnili* free and encysted failed to infect a rat, a mouse and a kitten.

(3) A kitten and a mouse failed to become infected with the human coccidium (Isospora).

(4) Lizards (Agama sp.?) harbour tetramitus and an amœba. The latter resembles *E. coli*, both in the free condition and the production of an eight-nuclear cyst.

(5) House-flies readily take up free and encysted forms of protozoa in fæces and can pass them from the gut as early as five minutes and as late as twenty hours after feeding.

(6) Wild flies captured in Alexandria often deposit in their droppings cysts of protozoa and eggs of worms which they have evidently taken up from human dejecta on which they have fed.

(7) A series of weighing experiments show that a single house-fly will take up one milligram of fæces in half an hour.

(8) Cysts of *E. histolytica* will survive in water but are killed instaneously by drying. The cysts are killed at once by 1 in 20 cresol solution.

Part V of the report, which consists mainly of detailed tables of the cases treated, will not be published in the JOURNAL OF THE ROYAL ARMY MEDICAL CORPS.

FUNCTIONAL CONDITIONS IN THE LIGHT OF HEAD INJURIES.

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A careful investigation of the functional nervous cases seen in a Military Hospital in war time forms an interesting commentary on the various theories that have been propounded as to the causation of functional conditions. The main theories are: (1) That they are pure neuroses; (2) that they are the effects of toxins, endogenous or exogenous; (3) that they are caused by abnormalities of internal secretion; (4) that they are due to psychic causes, and probably the only point upon which all would agree is that civilization plays a very large part in their production. Kultur has brought CO into prominence as a possible cause of neurasthenia and has shed an illuminating light upon the whole question. It is essential to take a wide outlook and it is obvious that in every case it is a general and never a local condition that has to be dealt with, and that names do not mean much. The labels psychasthenia, traumatic neurasthenia, functional paraplegia, hysteria, disorderly action of the heart, debility, shell-shock, and, dare I add, trench-nephritis and trench-feet, often indicate little more than the investigator's point of view and the patient's point of least resistance. We hear much of trench-feet, practically nothing of trench-hands, but they both exist and the difference between the two is only one of degree.

In fatal cases of head-injury, when there is not an obviously adequate cause for death, such as destruction or compression of brain substance, the result as a rule is put down to shock. The nature of shock has been elaborately investigated by Crile and his fellow-workers, who found that a similar clinical condition with essentially similar pathological appearances in the brain followed from four different causes: (1) Any exhausting peripheral or central stimulus; (2) psychic influences; (3) cerebral anæmia; (4) poisons, organic or inorganic, including toxins. The effects of shock are seen in different forms in all parts of the body, either as a direct result of nervous impulses or more indirectly as a consequence of vasomotor changes. The frequently prolonged functional effects of head-injuries may be regarded as a chronic phase of the condition which Crile has elucidated, and we must,

therefore, expect to find manifestations of it in every system. Indeed the neurasthenia which may follow a head-injury is probably to be looked upon as the purest of all functional conditions, in that it may arise instantaneously in a perfectly healthy individual from a single cause, though later other factors may, and probably usually do, help to maintain and even exaggerate it. Every case of neurasthenia makes an interesting study in the light of Crile's four causes: for when the condition has once become established a slight effort or peripheral stimulus, excitement or anxiety, sepsis or alcohol and many similar influences, may have an exhausting effect and precipitate a crisis. A head-injury then has two aspects: (1) an organic, concerned with the actual lesion and its direct consequences; (2) a functional, concerned with the neurasthenic effects upon the body as a whole.

I have spent the last four years in the study of functional conditions; first in general practice, then as resident in a General Hospital, and latterly as resident in a Military Hospital. The conclusion I have come to is that the living body may be compared to an electrical system, which may break down owing to faults either in the circuit or in the battery; and that while an organic nervous lesion may be compared to a break in the circuit, a functional nervous condition corresponds to an inefficiency of the battery affecting the whole circuit, but usually showing its effects more markedly in some parts than in others. There is nothing original about this idea, but the paths that have led me to it may perhaps be of some interest.

I started in general practice at the beginning of 1912. One of my first patients was a servant-girl, aged 26, who had been losing weight for more than a year. She had been subject to frequent headaches all her life; latterly these had become constant, and she was complaining also of giddiness, nausea, pain after food and diarrhœa. I could find no physical signs to account for her condition, and, being rather at a loss for a line of treatment, suggested that her headache might be due to her eyes. She said she was sure this could not be so; she had been sent up to London to have her eyes examined three years before; glasses had been ordered, but they had not helped her. Her headache seemed to be so much influenced by near-work that I persisted in my hypothesis and examined her eyes. She had mixed astigmatism requiring a 1D. cylinder for the one eye and a 0·5D. cylinder for the other. My result differed only very slightly from the old prescription and I hesitated to order the glasses. Still they improved her vision so

much that it seemed worth doing, and I sent her old frames up to London for new lenses. Before she had had them a fortnight she came back to ask me to get her a second pair in case she broke the first. She looked quite a different woman; her skin was clear and healthy, her headaches had vanished, her giddiness, nausea and diarrhœa had disappeared; in six weeks she put on a stone in weight; the idea of a convalescent home which had been proposed was abandoned, and she still remains perfectly fit.

This result made a great impression on me, and whenever a suitable patient arrived, who would allow me to do so, I worked out the refraction with the greatest care, always inquiring into general symptoms. Many cases were utter failures, but many did extraordinarily well, and the failures when I was certain my glasses were right were very few. My ophthalmic upbringing had been strictly orthodox, and I had thought small "physiological" errors of little consequence: yet almost all my best results were obtained in cases with small errors, and chiefly by the use of cylinders alone. I kept notes of my cases and learned to expect results in every system of the body, though those on the skin were the most obvious both to myself and others. My chief troubles were (1) the difficulty of persuading people that glasses could possibly help them; (2) the objection that many had to wearing glasses constantly; (3) the question of expense, for accuracy is hardly ever obtainable at the first attempt. Many patients had many different pairs and some were very difficult to keep, but in spite of prophecies of disaster my practice quadrupled in two and a half years.

It is more than forty years since Thomson and Norris's discoveries were made known to, and published by Weir Mitchell. Since then much has been written on this subject. Most ophthalmic surgeons are agreed that patients may be divided into two classes, those who can deal comfortably with any errors however great, and those who cannot deal with the smallest errors. The important point is not the amount of the error, but the nervous energy of the subject. The relief of nervous symptoms by glasses is often regarded as due to suggestion, and neurasthenia frequently looked upon as due to a defective will-power. But the functional effects of head-injuries are not as a rule regarded in this light, and the patient does not incur the stigma which is apt to attach to the patient with say "shell-shock." I will give three examples of neurasthenia following head injury: in the first there was undoubted destruction of brain-substance; in the second there was a fracture of the skull, but no definite brain lesion; in the third there was neither a

fracture nor, as far as is known, any destruction of brain-tissue.

Case 1.—Pte. K., aged 24, was wounded on July 19, 1915, in Gallipoli. A rifle-bullet entered the left side of the back of the neck and came out above the right eyebrow. He was unconscious for about a quarter of an hour, "vomited" blood at intervals for twenty-four hours, and had pyrexia for several days, the highest temperature recorded being 104·4. On admission to this hospital (September 1) there were many opacities in his right vitreous and with this eye he could only count fingers at one metre. There was a marked thrill beneath the upper part of his left sternomastoid and a roaring murmur widely transmitted could be heard there. An arterio-venous aneurysm was diagnosed probably between the internal jugular and the internal carotid. Other evidence led to the conclusion that there was damage to the right frontal lobe, the right optic nerve, and the left motor-cortex in the face region. He was sent away to the country and returned in January, 1916, when he was very depressed, was sleeping badly, complained of constant headache, frequent giddiness, and palpitation. The question of tying his carotid was discussed and a neurologist suggested that his right visual field might be of interest. His visual acuity was now right $\frac{6}{18}$ and left $\frac{6}{9}$. Under atropine with right + 1·50 S. + 0·375 C. vert., and left + 1·50 S. + 125 C. vert., he could read $\frac{6}{6}$ with either eye. He was ordered these cylinders with smaller spheres and in a week looked quite different and was sleeping better; his skin was healthy, his giddiness had gone, and he had very little headache. His palpitation soon disappeared, and he left hospital on March 27, quite cheerful and without having had his carotid tied.

Case 2.—Serjeant B., aged 28, was wounded on the right side of the head in Gallipoli, on August 9, 1915. He was unconscious for two days. On August 16 he was trephined in Egypt, and sent back to England in September. He was invalided for Home Service, but at his own request was sent to Salonika, in March, 1916. On the voyage the site of the wound became swollen, he had acute headache and a "fit." As soon as he landed he was taken to hospital, where the swelling was opened up, pus evacuated and a small depressed fracture found. On admission to this hospital he was complaining of frequent headache, double vision at night, palpitation, head-noises, and numbness of both feet. He could only read for a few minutes at a time. His visual acuity was $\frac{6}{9}$ with each eye, and right + 0·50 C. vert. and left + 0·50, 75 do. gave

him $\frac{6}{5}$. He said he would much rather be trephined again than wear glasses but finally consented to try them. With them he found that he could read as long as he liked; he had no diplopia, giddiness or head noises, and in a few days the numbness of his feet had disappeared, while his headache was very much less.

Case 3.—A wet sand-bag weighing about forty pounds fell upon the head of Serjt.-Major P., aged 28, on November 24, 1915, in Gallipoli. He was removed to ——— complaining of intense headache and giddiness. A week later he developed a bilateral internal strabismus with constant diplopia and head noises. He was considered to be suffering from cerebral tumour or specific basal meningitis. While on the voyage home the diagnosis was changed to disseminated sclerosis or neurasthenia. When he reached this hospital he could not move either eye outwards beyond the middle line of the orbit, the up and down movements were poor and there was slight lateral nystagmus. He had not been able to stand or read since his accident (six weeks). His visual acuity with each eye was less than $\frac{6}{60}$. With right + 0·375 C. vert. and left + 0·25 S. + 0·25 C. 70 do. he could read $\frac{6}{5}$ with either eye, had perfect binocular vision and could read ordinary type comfortably. Within a week he could stand without support and walk with the aid of a stick, while his headache, giddiness and head noises had ceased. Whenever he took off the glasses his strabismus and diplopia returned instantly. Two other combinations were tried, but failed to relieve his symptoms. This case was seen by all the four ophthalmic surgeons on the staff of the hospital.

There are several points of interest about these cases. The highest cylinder ordered was 0·50. The first patient was sent to the Ophthalmic department, not to have the refraction estimated, but to have the visual field worked out. Low though his error was, the astigmation of the right eye was three times as much as that of the left. If this patient had been ordered + 0·25 C. for each eye, he would almost certainly have found the glasses intolerable, as they would have produced an artificial indirect astigmatism of an eighth of a dioptre in the left eye, and have left an uncorrected direct astigmatism of the same amount in the right, the most pernicious of all varieties of asymmetry. In Case 3 there was asymmetry of every variety—spherical, cylindrical, and axial. It is a remarkable case from whatever point of view it is looked at. Asymmetry is always of the utmost importance, and the mere covering of one eye will frequently give the greatest possible relief in cases of head injury or other forms of neurasthenia, provided it

is the non-dominant eye which is covered. The compensation of the dominant eye—usually, of course, the right—is almost always better than that of the other. Pte. H., who had a hernia cerebri, and was under the care of Mr. H. W. Carson, discovered for himself that he was much more comfortable if he brought his head-bandage down over his left eye. He did very well, but after some weeks tried to use both eyes together; in less than an hour he had intense headache and general convulsions, and was put back to bed unconscious. A so-called amblyopic eye may be a great source of trouble unless the image formed by it is entirely suppressed. The covering of one eye, of course, puts out of action not only the muscles concerned with correcting the error of the covered eye, but also those that maintain the parallelism of the visual axes, to say nothing of the influence on the brain of a blurred image.

It must not be thought that these cases are exceptional. The mere shock of a head injury may kill, and in any case it lowers the efficiency of the whole nervous system, quite apart from the direct consequences of the actual lesion. The patient becomes, temporarily at least, a neurasthenic—one who cannot fulfil the normal functions of life in the normal way. Ordinarily the refractive errors, which exist to a greater or lesser degree in almost every one, are compensated by a continuous neuro-muscular effort, so habitual as to have become practically a reflex. No one would be surprised at the compensation for, say, a mitral stenosis breaking down under the strain of the War. The same reasoning applies to the compensation for refractive errors.

Pte. R., aged 23, was buried in a mine explosion in France; during the few days he spent in hospital he complained of not being able to see as well as formerly; a −3D. sphere was ordered for each eye, with which he could read $\frac{6}{6}$. He went back to the trenches, and wore the glasses for three months with comfort. He was then again buried; his general condition was this time much worse, and he was sent back to England. He complained that ever since his second accident his glasses had been intolerable, and that he could not wear them for more than a few minutes at a time. His visual acuity with his glasses was right $\frac{6}{18}$, and left $\frac{6}{12}$. With right − 2·75 S. − 1·00 C. vertical, and left −2·75 S. − 0·75 C. vertical, he could read $\frac{6}{6}$ with each eye easily, and they were perfectly comfortable. The − 3D. spheres created an artificial mixed astigmatism of right + 0·25 S. − 1·00 C. and left + 0·25 S. − 0·75 C. While he was fit he could deal with these artificial errors quite easily; after his second accident he had become neurasthenic and

could not compensate them. Just as this patient could not deal with his artificial errors, so the men who had been made neurasthenic by their head injuries could no longer correct their natural defects.

The discovery of one functional condition should lead to the routine search for others. Life itself is a nervous phenomenon, and there are manifestations of lowered nervous energy in every system. Mental changes of any variety, from a mere transient confusion to actual insanity, may take place. There may be somnolence or insomnia. Headache is very common, eye symptoms abound, and giddiness, which may be caused by a failure of any link in the chain upon which equilibrium depends, is general. The ear with its delicate mechanism is easily upset, fails to hear what it should hear, and hears sounds that do not exist. The skin may lose its healthy tone; the hair becomes scurfy and tends to fall. The sweat-glands are often obviously affected, and it is not unreasonable to suppose that other glands also are disturbed, producing excessive, deficient, or unnatural secretion. Crile has shown the acute effect of shock upon the suprarenals, and fright is an accepted cause of Graves's disease. The alimentary canal may show abnormalities of peristalsis, of secretion, and of absorption, absorbing what it should not absorb and failing to absorb what it should absorb. A colectomy undoubtedly diminishes the absorption of toxins, but the question at issue would appear to be rather why the colon absorbs toxins at all. The rate and rhythm of the heart may be affected, and want of tone may lead to dilatation. The respiratory manifestation would appear to be spasmodic asthma. Some forms of anæmia may be expressions of neurasthenia affecting the blood-forming tissues. Affections of the motor nerves are shown in tremors, convulsions, and pareses; while on the sensory side there are neuralgias, anæsthesiæ, hyperæsthesiæ, paræsthesiæ. One effect on the vasomotor system is seen in Raynaud's disease, which bears a striking similarity to certain cases of trench feet. Resistance is lowered; infections that have lain dormant for years, or have previously been strictly localized, may become active or spread. Psychic influences, fear and excitement, grief and anxiety, may have effects they would not have upon a normal individual.

On some such lines as these it would appear that a functional case should be investigated. Whatever the route by which it has been reached, the condition once established is undoubtedly a general one: fatigue, poisons, psychic influences, glandular deficiencies, injuries, may form links in a vicious circle: the intro-

duction of a single element may produce a crisis, its removal may effect a cure.

Neurasthenia, in the widest sense of the term, can, as I have said before, be compared to the effects upon an electrical system of an inefficient battery. The body, unfortunately, cannot be provided with a new battery, but much can be done to give the old battery less work to do. The patient who has had a serious head injury is put to bed and rested in every possible way.

During the period of rest in bed, almost the only organs of his body upon which any constant voluntary effort falls are his eyes. At first the mere stimulus of light may be intolerable to him and he lies as far as may be with his eyes shut. If he opens them, blurred and ill-fused images only increase his headache, nausea and giddiness. The sudden paresis of an external ocular muscle may cause headache, giddiness, and nausea; the effects of a paresed ciliary muscle may be the same, but the cause is not equally obvious. Later he is probably comfortable as long as he lies still, but any change of position is apt to reproduce his symptoms. The next step is probably an attempt to read, and the difficulties of near are added to those of distant vision. When he gets up more frequent changes of position and increased efforts of every kind cause a recrudescence of his troubles. In fact, throughout his convalescence he is dogged by difficulties caused him by his eyes, because without them he can do little or nothing. A large proportion of his diminished available nervous energy is spent upon them, the rest of his body is starved and various functional effects follow or are kept up. It can easily be proved that in the vast majority of these cases the visual acuity depends upon the refractive error, and most of them can be made to read $\frac{6}{6}$, $\frac{6}{5}$, or $\frac{6}{4}$ under atropine. What has happened to them is that, just as they would probably find a ten miles' walk an impossibility, so they cannot maintain their ocular compensation or only do so at the expense of other parts of the body.

An accurate correction of the refractive errors removes a constant insidious source of nerve-waste, takes much work off the battery and in the debilitated conditions described frequently makes all the difference to the patient. It is not a question of what the man sees but at what expense to himself he sees. If a neurasthenic can read $\frac{6}{6}$ or more without glasses he is almost certainly doing so to the detriment of some other part of his body. The object to be aimed at is to leave a minimum, and, as far as possible, equal defect for each eye to correct, without changing

the nature of the defect. An over-correction does no permanent good and may do a great deal of harm. An under-correction of the astigmatism generally leads to an over-correction of the spherical element. If the real error is −0·25 C. axis vertical and +0·25 C. axis horizontal is ordered, the effect is to change the original myopic astigmatism into a pure myopia, and substitute an unnatural for a natural defect. The ordering of +0·25 S. +0·25 C. when the prescription should be +0·50 C. creates an artificial myopic astigmatism of a quarter of a dioptre.

Anyone who cares to take the trouble to accurately correct the refraction of neurasthenics will find that he will get extraordinary results, but he will only get them by very patient labour and hardly ever, except in some cases of simple astigmatism, at the first attempt, and he must always remember that he is playing with edged tools. The best results are to be obtained with small errors normally well within the patient's powers of compensation. A big defect is very easy to correct approximately, but when that has been done one still has to search for the accurate correction which will put the eyes practically out of the circuit. There is an enormous field in this direction: refraction work of the ordinary type is of the dullest; once it is looked at from the point of view of general symptoms it becomes fascinating and throws light upon problem after problem. But no one who attempts it must expect to be regarded as anything but a charlatan even by his patients. Just as a patient will believe that anything is wrong with him rather than his eyes, so he will believe that anything has cured him rather than his glasses—until he breaks them.

For permission to publish this I am indebted to Lieutenant-Colonel R. J. C. Cottell, R.A.M.C., commanding the King George Hospital, and to my various chiefs for much help and encouragement.

Clinical and other Notes.

THE WALLACE-COWELL THEATRE TRAILER.

By Captain E. M. COWELL.
Royal Army Medical Corps.

The mobility of a casualty clearing station has always been a difficult problem. In particular the question of providing safe and rapid transport for the easily damaged furniture and surgical equipment of the operating theatre has for a long while occupied the minds of those responsible for these matters.

As far as the operating section of a casualty clearing station is concerned, the question would appear to be solved by the introduction of the "Theatre Trailer" with its portable furniture and sectional shelves.

In September, 1916, Colonel Cuthbert Wallace, C.M.G., proposed the idea of building a light body to be carried on a two-wheeled trailer, which would be drawn behind one of the casualty clearing station lorries. It was suggested that the interior of the vehicle should be fitted with shelves and pigeon-holes like the fittings on board ship.

The original idea, however, was amplified, and a structure finally built which could be easily lifted down off the wheels to serve as a theatre annexe, splint, or sterilizing room, or even a small-operating theatre for one table. Moreover, instead of fixed pigeon-holes or compartments, a set of light but serviceable cupboards and shelves was devised, to serve the double purpose of providing permanent theatre furniture and also to secure both an easy and safe way of carrying dressings and all the equipment required to supply a large operating theatre.

Reference to the accompanying illustrations will make clear the various points mentioned in the description of this vehicle and its contents.

The body or superstructure consists of a pitch-pine framework covered with waterproof canvas, painted and varnished. Greased cloth windows provide ample illumination for the interior, which is closed at the tail end by a double curtain door. The dimensions (see Appendix I) are: Length 14 feet, width 6 feet 6 inches, height 6 feet 6 inches. The total weight of the superstructure and contents is one ton. During trial journeys it has been found that as much as one ton five cwts. can easily be carried behind the trailer lorry itself loaded to 2½ tons.

To prepare for travelling the empty superstructure is lifted up by four men while the trailer proper is run underneath. Four iron clamps hold the body in position.

The furniture, consisting of a series of cupboards and shelves, is now loaded. Each cupboard runs on four wheels to facilitate moving, and is

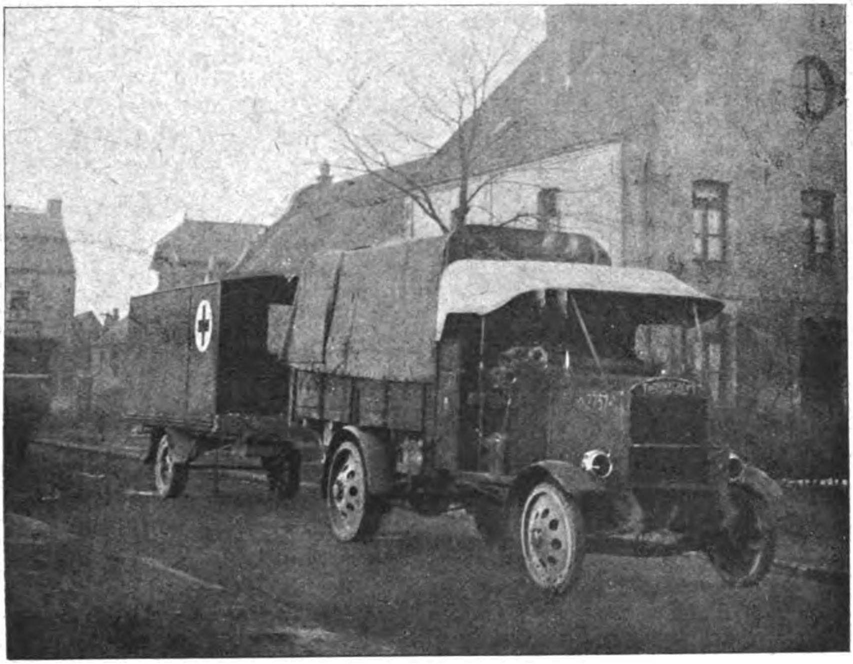


FIG. 1.—The Wallace-Cowell Theatre Trailer on the road, behind the tractor lorry. It follows readily wherever the lorry can go. Should the motor "break down" the trailer may be drawn to its destination by a pair of heavy draft horses hitched to either side of the traction pole.

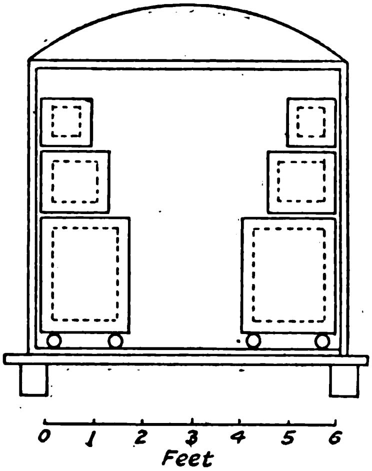


FIG. 2.—Cross Section. Showing arrangement of cupboards and superimposed shelves. The gangway permits of ready access to, and removal of any piece of furniture separately without disturbing the rest.

fitted to hold and carry without damage—dressings, instruments, bowl and enamel ware of the scheduled equipment (A.F.G. 1098-66), as well as Bowlby's outfit and the marmites, etc., in use in almost every casualty clearing station theatre.

Two cupboards are set apart for sterile dressings, overalls and towels, and contain a sufficient supply for [1]one day's operating. The rest of the

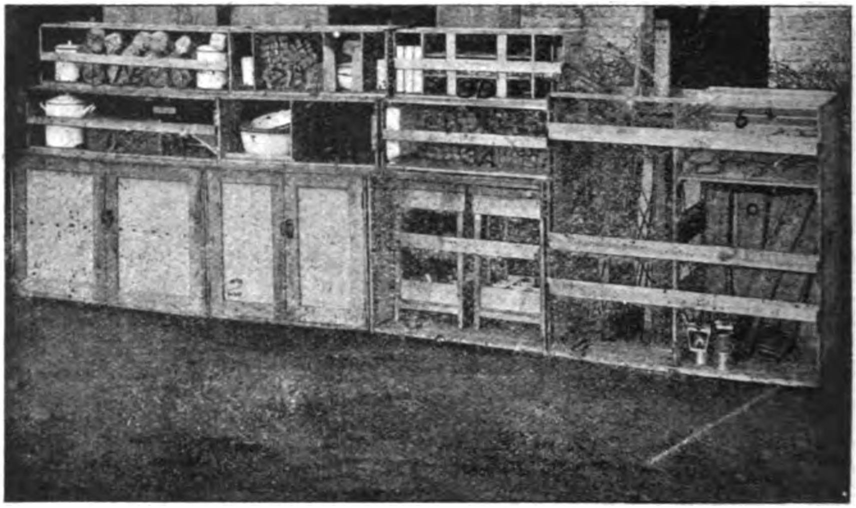


FIG. 3.—Contents of left-hand side lifted out of the trailer.

Cupboard 1. *Dressings Cupboard.* All cupboards are mounted on small wheels or castors. Doors made to take off their hinges to economize space. Shelf as dotted line. Length, 4 feet; front to back, 2 feet; height, 2 feet 6 inches.

Cupboard 2. *Instrument Cupboard* (doors open in fig. 5). Eight shelves, all interchangeable, and made to fit on one side entirely for travelling. The other half of the cupboard may now be filled with dressings. Length, 3 feet; front to back, 2 feet; height, 2 feet 6 inches.

Cupboard 3. *Two Anæsthetic Tables* (for details see Appendix IVA). When unloaded the cupboard serves as washing bench for surgeons. The jugs and waste-water pails stand inside. Length, 3 feet; front to back, 2 feet; height, 2 feet 6 inches.

Cupboard 4. Splint rack. Three compartments: (*a*) Long splints, thigh; (*b*) short splints, arm; (*c*) leg splints. Length, 4 feet; front to back, 2 feet; height, 4 feet.

Shelves: 1A, 1B; 2A, 2B; 3A, 3B. Shows method of packing. For details see Appendix IVB. The shelves are fitted with dowels on their under surface which fit into slots cut in the piece below. For use see fig. 5.

dressings are sterilized in Schimmelbusch drums, of which six complete sets are carried.

In all, sufficient dressings for 500 operations may be stored in the trailer.

Lotions are made up in quart bottles and packed in a specially

[1] About 150 major cases—two surgeons and four tables.

designed case fitted in one of the shelves. Boiled water and saline are taken in sterilized petrol tins. The instruments are packed in "bandoliers," made by stitching together webbing straps from the field fracture box, which are strapped on to the shelves of the cupboard. If necessary, the eight shelves can all be placed on one side, thus allowing the rest of the cupboard to be filled with dressings.

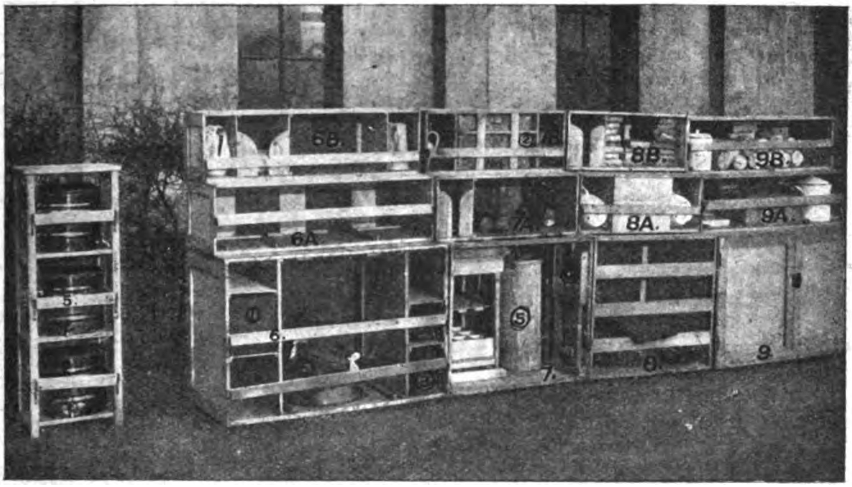


FIG. 4.—Contents of right hand side. No. 5 stands across the far end of the vehicle.

No. 5. Stand for copper cauldrons. Each cauldron may be conveniently boiled up on a Primus stove.

No. 6. Primus cupboard, tin-covered top. Shelves for Primus stoves. (1) Metal stand which takes Primus stove and supports sterilizer (2) in 7B. The paraffin and methylated spirit are carried in petrol tins (3). The central space may also carry four anæsthetic stools (4) in 7. Length, 4 feet; front to back, 2 feet; height, 2 feet 6 inches.

No. 7. Anæsthetic cupboard. Two tables advisable. The generator of "atoz" acetylene lamp (5) may be carried in the lorry. Anæsthetic stools (4) carried in No. 6. Length, 3 feet; front to back, 2 feet; height, 2 feet 6 inches.

No. 8. Cleaning materials cupboard. Solid top, movable bars. When empty used for scrubbing mackintosh sheets, etc. Carries pails, cleaning materials, mackintosh sheets, blankets, etc. Length, 3 feet; front to back, 2 feet; height, 2 feet 6 inches.

No. 9. Dressings cupboard. Identical with No. 1. Sterilized dressings carried in pillow slips.

Shelves: 6A, 6B, 4 feet lengths; 7A, 7B, 8A, 8B, in use in fig. 5, 3 feet; 9A, 9B, 4 feet lengths.

Three[1] anæsthetic tables and folding stools are packed into two cases, which, when unpacked, can be used as surgeons' washing-up benches. The bottom shelf of all three anæsthetic tables contains nine com-

[1] Further experience has shown it is advisable to increase the number to four.

partments, each of which will hold a two-pound bottle of chloroform or ether. Two other shelves contain the anæsthetic apparatus, masks, gauze, etc.

The remainder of the cupboards comprises: (1) a tin-covered table with pigeon-holes for Primus stoves and compartments for petrol tins filled with oil and methylated spirit; (2) a cupboard for cleaning materials, dirty dressing, pails, etc.; (3) a rack for splints; and (4) a stand for the lotion copper cauldrons which are so valuable an addition to the theatre equipment. Two longitudinal bars are fitted to two movable transverse bars and prevent lateral movements during the journey.

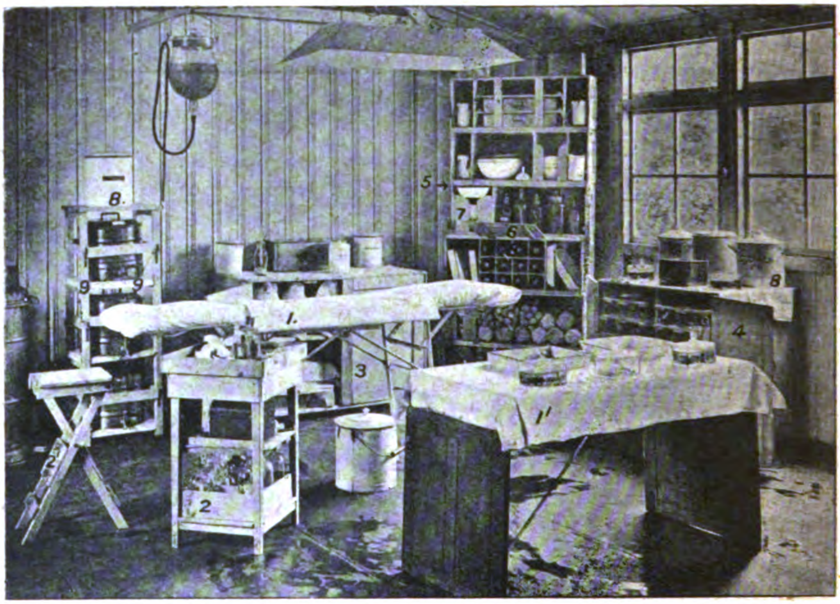


FIG. 5.—Wallace Cowell Trailer furniture in actual use, with regulation pattern table, operating and case (1), 1 foot; (2) anæsthetic table and stool, 2 feet; (3) dressings cupboard—top used as a table; (4) instrument cupboard—the doors are now made to lift off and thereby save space; (5) tier of shelves, 3 feet length; (6) lotion case—iodine and concentrated solutions in quart bottles; (7) shows method of introducing bowls into compartment; (8) marmites—different sizes—carried in 8 A and B, 9 A and B, 1 A and B; (9) cauldron stand. The four-foot length shelves are also placed where required and make convenient linen cupboards, with tops useful as table.

The sectional shelves are made to fit one above the other, and may be conveniently built up in any order that may be desired to form dressers or small cupboards. Used in this way they are particularly useful in tents where it is impossible otherwise to utilize the walls for shelves. When packed in the superstructure the double tier of shelves rests on the tops of the cupboards. Each row is kept in position by

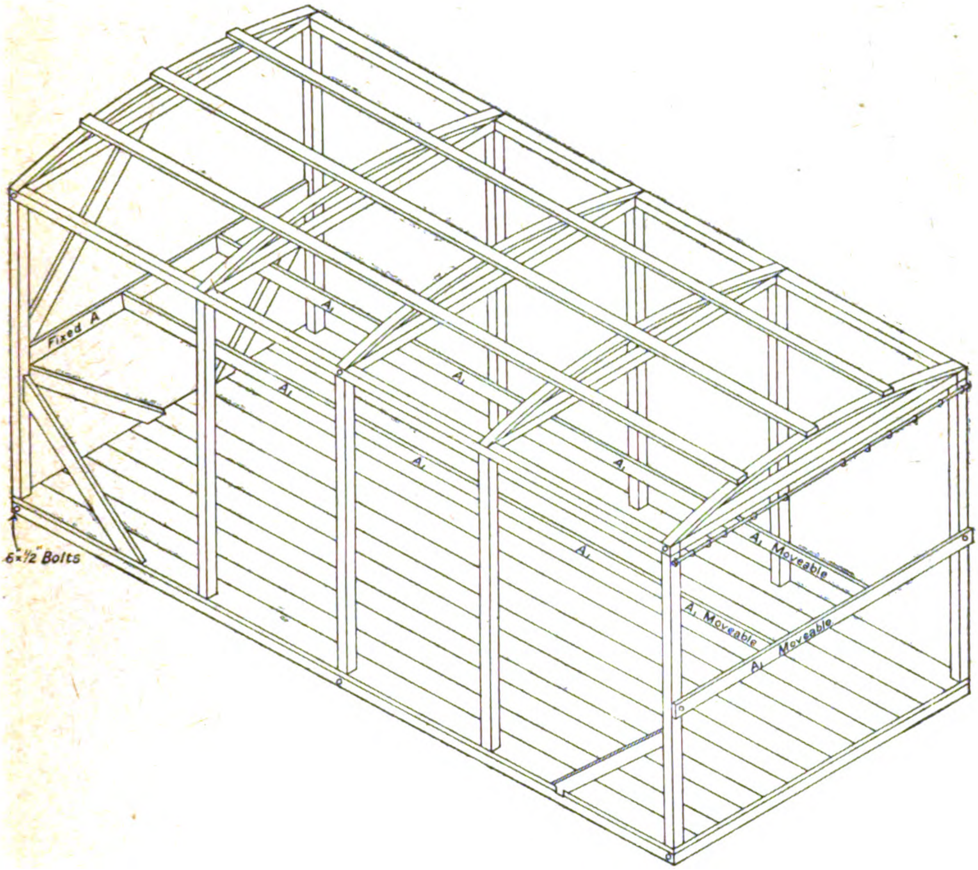
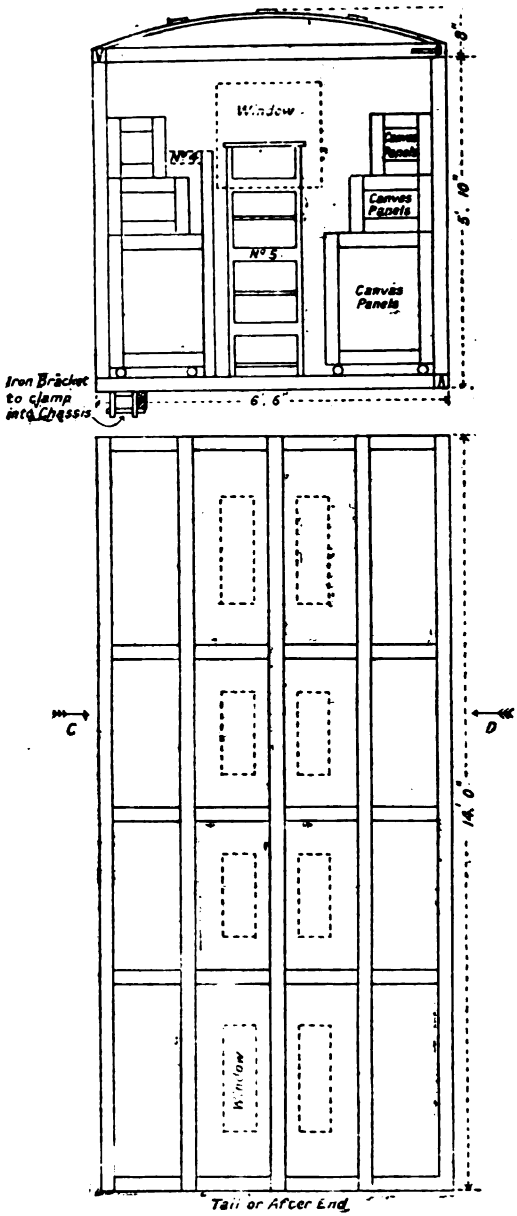


FIG. 6.—Framework of "superstructure" or "body." Tracing of isometric projection (not showing furniture). Scale ½ inch to the foot.

Details.—Framing, pitch pine, 2½ inches by 2 inches; braces, pitch pine, 2½ inches by 1 inch; roof-laths, pitch pine, 2½ inches by ½ inch; fixed bar A, pitched pine, 2½ inches by 1 inch; portable bars A1, pitched pine, 2½ inches by 1 inch; floor T and B, red pine, 6 inches by ⅞ inch. Structure to be covered with canvas and have greased cloth windows as shown in plan and elevation. Frame and canvas doors will replace curtain at tail end. Length 14 feet, width 6 feet 6 inches, height 5 feet 10 inches, 6 feet 6 inches in centre.

Elevation (after end).



Plan showing details of roof.
FIG. 7.
Scale ½ inch to the foot.

dowels fixed to the under surface. On the road it is found that even over rough *pavé* there is no movement of the contents of the cupboards and shelves. Should the contents of any pigeon-hole commence to rattle a packet of dressings can be wedged into the required space.

Two Royal Army Medical Corps orderlies ride in the trailer and two on the lorry, in addition to the two Army Service Corps drivers. These six men can pack the loaded furniture into the trailer in ten minutes.

The lorry which draws the trailer is of the usual three-ton pattern on the establishment of each casualty clearing station. A load of 2½ tons is carried composed of stretchers, blankets, cooking, feeding, and nursing requisites sufficient for 100 serious surgical cases for two days (see Appendix II).

In addition a marquee (hospital pattern) and operating tent are carried to provide accommodation for the new theatre if required. The articles composing this load may be kept ready in store, and can be packed on to the lorry in twelve minutes.

Those who in the early days of the War were obliged to improvise theatre cupboards and other furniture from packing cases, bacon boxes, and so on, will be able to appreciate fully the value of this system of portable furniture which provides all that is necessary to run a permanent theatre of three tables, either in tents or a building.

Lieutenant-Colonel G. H. Goddard, R.A.M.C., by whose keen interest, able management and helpful advice, the building of the first trailer and theatre furniture has been made possible, writes thus:—

The following advantages are obtained by the addition of this trailer to the transport of a casualty clearing station.

(1) Careful and rapid transport of the valuable and delicate equipment of an operating theatre.

(2) Possession of the operating room furniture, which is ready for immediate use under all circumstances.

(3) Utilization of regulation equipment, to which additions can easily be made if required.

(4) Provision of an extra store-room always at hand for dressings, sterilizers, splints, etc.

(5) The existence of a rigid structure which can be readily moved by road, train, or ship.

(6) The cost of materials and manufacture in comparison with the above-mentioned advantages is inconsiderable.

Appendices I to V give a complete inventory of the equipment carried.

The actual making of the first trailer and contained furniture has been carried out by Acting-Cpl. R. W. Kirtley, R.A.M.C., assisted by two Royal Army Medical Corps privates. The greatest credit is due to this non-commissioned officer for the technical ability and skilful workmanship he has displayed in carrying out the ideas submitted to him in spite of considerable difficulties.

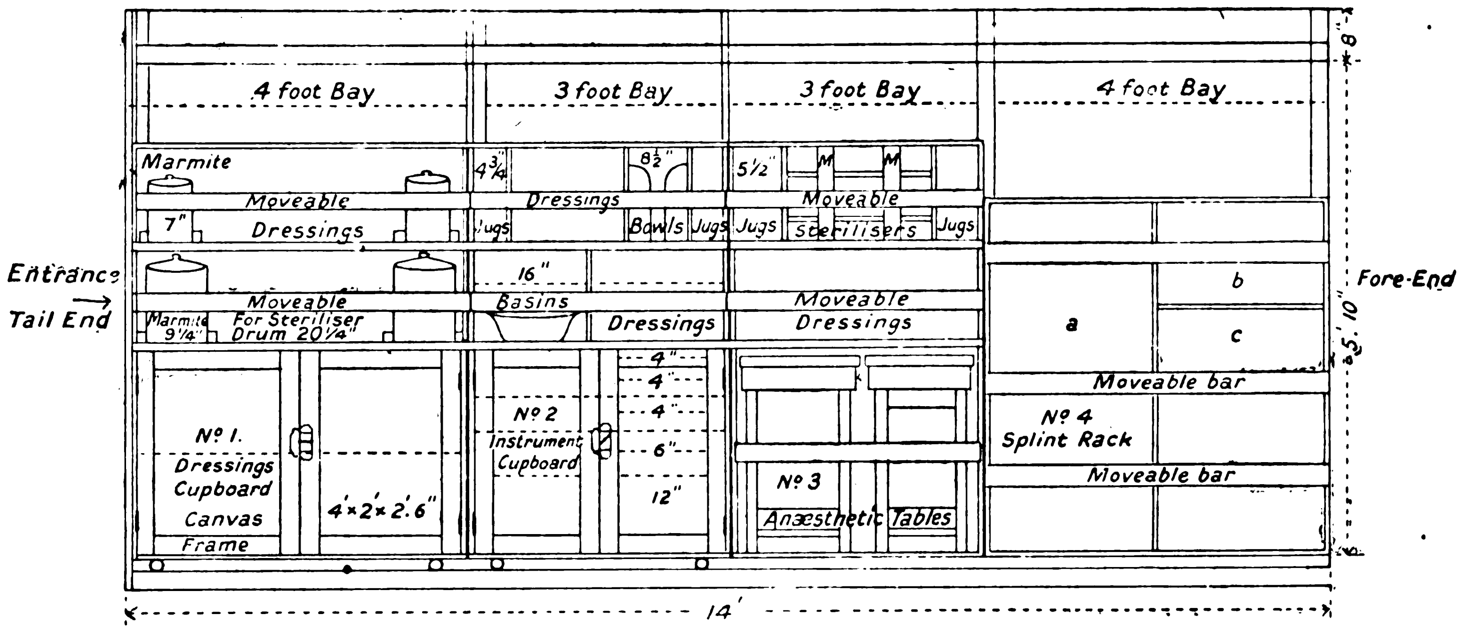


FIG. 8.—Longitudinal section showing details of furniture of left-hand side. (Compare photograph, fig. 3.)
Scale ½ inch to the foot.

Details.—(1) All ends, backs, doors, and shelves to be framed and have canvas panels. (2) Cupboards Nos. 1, 2, and 3 to have solid tops and bottoms. Other tops and bottoms to be framed and ½ inch panels. (3) Shelves carry moveable bars. (4) Shelves in No. 2 Cupboard are interchangeable and fit one above the other. (5) All top sections (shelves) to have one-inch dowels in underside to hold in position when travelling. (6) Cupboard No. 3 carries two anæsthetic tables.

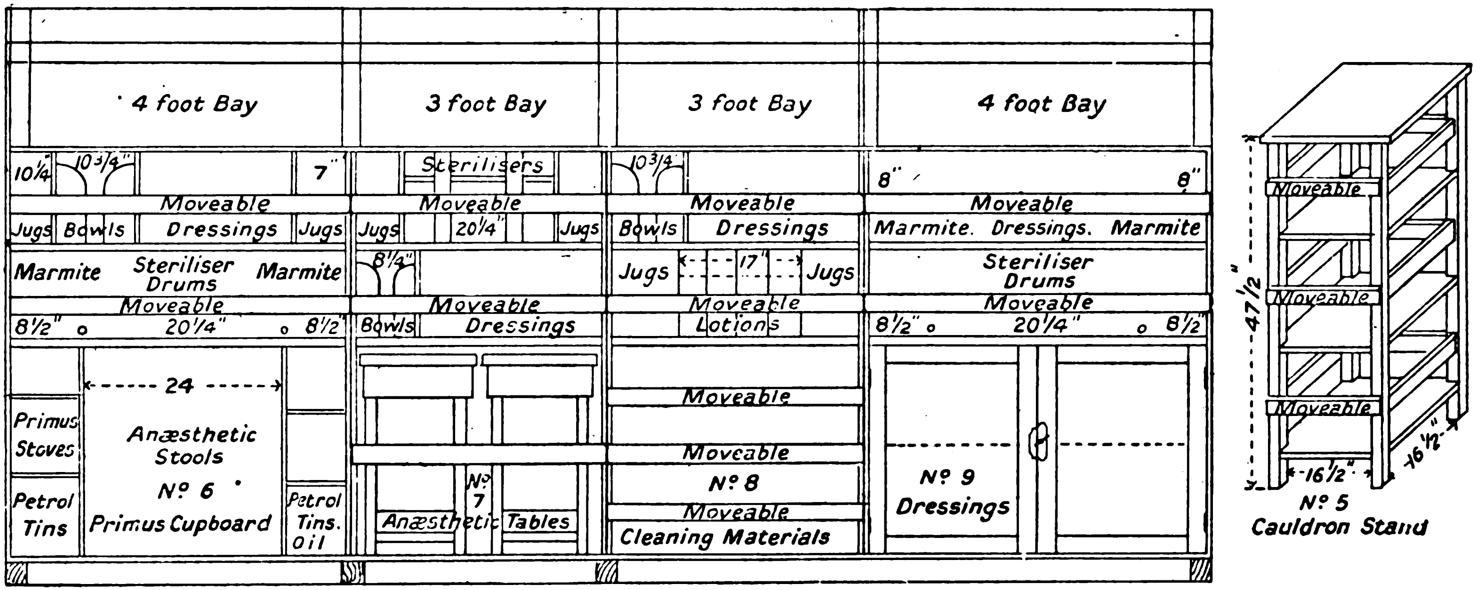


Fig. 9.—Longitudinal Section, right-hand side. (Compare with photograph, fig. 4.)
Scale ½ inch to the foot.

Details.—No. 6. Primus cupboard, solid top, tin covered. Compartments carry stoves and oil in petrol tins. Centre carries four anæsthetic stools.
No. 7. Two anæsthetic tables, each nine 2-lb. bottles ether or chloroform.
No. 8. Solid top, moveable bars.
No. 9. Dressings, solid top.

These cupboards are held in position when travelling by moveable longitudinal bars which fit into the transverse bars—also moveable—shown in the isometric projection.

No. 5. Stands under the end window and carries the three copper cauldrons. A pair of steps (not drawn) is hooked on to the front of this stand; used for entering and leaving the trailer.

APPENDIX I.

Dimensions and Weight of Body and Furniture.

A.—Body.

Length	14 feet	
Width	6 feet 6 inches	
Height	6 ,, 6 ,,	(in centre)
Weight (empty)	700 lb.	
,, (with loaded furniture)	1,564 ,,	
* Total	2,264 lb.	1 ton approx.

* The chassis itself weighs one ton. Pitch pine has been used for subsequent sets of furniture and weighs rather more. It has been found by experimental tests that this additional weight is easily taken in the trailer behind the loaded lorry.

B.—Furniture (loaded).

No. 1 Cupboard.		Dressings	121 lb.
,, 2	,,	Instrument	145 ,,
,, 3	,,	Anæsthetic	102 ,,
,, 4	,,	Splint	177 ,,
,, 5	,,	Cauldron stand	45 ,,
,, 6	,,	Primus	90 ,,
,, 7	,,	Anæsthetic	78 ,,
,, 8	,,	Cleaning utensils	46 ,,
,, 9	,,	Dressing	121 ,,
Shelves.	No. 1.	A and B. Loaded	95 ,,
,,	,, 2.	,, ,,	69 ,,
,,	,, 3.	,, ,,	105 ,,
,,	,, 4 and 5		None.
,,	,, 6.	A and B. Loaded	100 lb.
,,	,, 7.	,, ,,	108 ,,
,,	,, 8.	,, ,,	82 ,,
,,	,, 9.	,, ,,	80 ,,
		Total	1,564 lb.

APPENDIX II.

Contents of Tractor Lorry.

Article			Quantity	Weight
Bedding.	Blankets		200	800 lb.
	Palliasses		50	150 ,,
	Pillow cases		100	32 ,,
	Sheets, draw		24	24 ,,
	,, waterproof		100	250 ,,
	Stretchers		25	750 ,,
Clothing.	Pyjamas	Pairs, 100; bales	2	200 ,,
	Shirts	,, 100 ,,	1	120 ,,
	Socks	,, 300 ,,	1	83 ,,
Cooking.	Dixies	Nest of 10	—	80 ,,
Utensils.	Stove soyers		1	250 ,,
Food.	Medical comfort panniers		2	162 ,,
	Oxo	Case	1	28 ,,
	Milk	,,	1	28 ,,
Lighting.	Carbide	,	2	120 ,,

Article			Quantity	Weight
	*Lamps, Atoz, complete		3	135 lb.
	,, hurricane	Case	1	140 ,,
	,, paraffin	Drum	1	50 ,,
Medical and Surgical	Field fracture box		1	82 ,,
	,, medical pannier No. 1		1	182 ,,
	,, ,, ,, reserve No. 2		1	182 ,,
	Field surgical panniers 1 and 2		2	174 ,,
	Medical companions		2	25 ,,
	Surgical haversacks		2	14 ,,
	Reserve dressing boxes		6	282 ,,
	Chloroform and ether	Cases	2	50 ,,
Nursing Equipment.	Nursing pannier A and B (see Appendix III)		2	170 ,,
	Stools, night	Nest	1	28 ,,
Tentage.	Marquee, hospital pattern		1	512 ,,
	Tent, operating		1	181 ,,
	Poles, flag, distinguishing		1	61 ,,
*Theatre.	Tables, operating	Cases	3	295 ,,
Accessories.	Irrigator stand		1	10 ,,
Tools.	Selected, carpenter's	Bag	1	10 ,,
	Approximately 2 tons, 9 cwt.			5,478 lb.

* Four may be carried. With two "surgical teams" it has been found by actual practice that much time is saved by the use of two tables for each team. With this "twin-table" system a second patient is anæsthetized and prepared while the first is cleaned up and bandaged.

Only in very exceptional circumstances would it be necessary to load the tractor lorry according to the above list. The extra table, an autoclave, dressings and splints, together with additional personnel and stretchers, should form the load of this lorry.

APPENDIX III.

NURSING PANNIERS CONTAINING EMERGENCY EQUIPMENT FOR 100 SERIOUS CASES.

Pannier A.

Feeding bowls	50
Feeding cups	30
Sputum mugs	18
Cooking pails—nest of 8	1
Spoons	50
Beatrice stove	1
Teacloths	20
Towels	30

Total weight, 90 lbs.

Pannier B.

Bedpans	5
Urine bottles	12
Lotion bowls	12
Washing bowls	5
Hand scrubbing brushes	2
Canvas buckets	2
Kidney dishes	2
Washing flannels	12
Soap	lb. 10
Stomach warmers	20

Total weight, 80 lb.

APPENDIX IV.

Inventory of Contents of Furniture.

A. Cupboards—Left Hand Side.

No. 1. *Dressing Cupboards* (contents sterilized):—

Bottom shelf (see Note 1)	Overalls, 12, packed in pillow case	1
	Towels (144 triangular bandages) .. .. pillow case,	1
	Swabs (450 per pillow case) .. .. ,,	2
	Cellulose (96 pieces per pillow case) .. ,,	1
Top shelf ..	Gauze (150 pieces per pillow case).. .. ,,	3
	Gauze rolls (18 per pillow case) .. .. ,,	1
	Many-tailed bandages, 30 .. .. ,,	1

No. 2. *Instrument Cupboard*:—

Left-hand side	Eight shelves, instruments strapped in bandoliers.	
	Below: Strapping, 3 dozen reels; syringes; instruments, operating, 1 case; needles; ligatures; gloves; safety pins, etc.	
Right-hand side (see Note 2)	Small Schimmelbusch drums packed	12
	Field medical cards, pencils, operation book.	

No. 3. *Anæsthetic Case* (2 tables):—

Each table consists of top tray—

Masks, 2; gag, tongue forceps, etc.

Drop bottles, lint, hypodermic syringes, pituitary extract, brandy, antitetanic serum, etc.

Middle tray—

Gauze for masks, Shipway's apparatus, etc.

Lower tray—

18 lb. chloroform in 2-lb. bottles.

No. 4. *Splint Rack* (see Note 3):—

Thomas's hip splints	12
Liston's long splints	12
Back splints, leg	24
Arm splints, various	36
Tow for padding splints .. .. .. lb.	50

Right-hand Side.

No. 5. *Cauldron Stand*:—

Three copper cauldrons carried empty.

No. 6. *Primus Cupboard*:—

Shelves ..	Primus stoves	6
	Paraffin in petrol tins	2
	Methylated spirit in petrol tins	1
	Candles, matches, brushes (scrubbing), soap, etc.	
Centre ..	Atoz acetylene lamp (see Note 3).	
	Acetylene lamp, hand	2
	Hurricane lamp	1
	Dressings (see Note 2).	

The four anæsthetic stools may be carried here instead of Cupboard No. 7.

No. 7. *Anæsthetic Case*:—

*One table (see No. 3).	
Stools, folding	3
Generator of Atoz lamp (see Note 3).	
Jar of irrigator	1

*Two tables now carried (see Note under No. 6, p. 710).

No. 8. *Cupboard for Cleaning Materials* (see Note 5)—
Bath for washing mackintosh sheets; pails, boilers, &c.; blankets, 3; mackintosh aprons, &c.; dirty dressing pails, 2.

No. 9. *Dressing Cupboard* (see Note 1):—
Identical with No. 1.

B. Shelves—Left-hand Side.

No. 1A.	Marmites, large size (gloves)	2
	Schimmelbusch drums, large	2
	Bandages, 3-inch, packets of 10	16
	Inventory board.	
No. 1B.	Marmites, small size (ligatures, etc.)	2
	Wool, 1-lb. rolls (see Note 6)	12
	Bandages, triangular, packets of 10 (see Note 7)	16
No. 2A.	Bowls, enamel, 16-inch	3
	,, ,, 12-inch	6
	Bandages, triangular, packets of 6 (see Note 7)	74
No. 2B.	Jugs, enamel, 1 pint	4
	Bowls, enamel, 8-inch	6
	Bandages, 3-inch, packets of 10 (see Note 7)	26
No. 3A.	Instrument trays, largest size	6
	Gauze rolls, bundles of 12	20
No. 3B.	Schimmelbusch sterilizers (see Note 8)	1
	Instrument trays, small	6

Right-hand Side.

No. 6A.	Marmites, large, Lane's infusion bags, etc.	2
	Schimmelbusch drums, large	2
	Bandages, 3-inch, packets of 10	20
No. 6B.	Bowls, enamel, 10½-inch	3
	,, ,, small sizes	12
	Methylated spirit cans, small	2
	Jugs, 2-pint	2
	Wool in 1-lb. rolls (see Note 3)	10
No. 7A.	Kidney dishes, various	12
	Gauze rolls, in packets of 12	16
No. 7B.	Schimmelbusch sterilizers (see Note 8)	2
	Jugs, 1-pint (see Note 3)	2
No. 8A.	Lotion bottles, 2-pint, screw top (see Note 3)	6
	Jugs, largest size	2
No. 8B.	Bowls, enamel, 10-inch, and various	12
	Cellulose, 1-lb. rolls	10
No. 9A.	Marmites, large, Carrel's tubes, etc.	2
	Schimmelbusch drums (see Note 7)	2
	Bandages, 3-inch, packets of 10 (see Note 3)	16
No. 9B.	Marmites, small, Higginson's syringes, etc.	2
	Bandages, 3-inch, packets of 10	20
	Cellulose rolls	10

NOTES.

(1) Dressings are most conveniently packed in double pillow cases—each when full weighs 5 lb.—and sterilized in the Thresh apparatus. The cupboards will hold double the amount, if necessary.

(2) Only if urgently required.

(3) Double quantities, if necessary.

(4) May be packed with dressings.

(5) Should be loaded early. This cupboard now has a solid top and portable bars in front, so that this does not apply any longer.

(6) Eighteen rolls, if necessary.

(7) If required.

(8) Room for three.

THE USE OF PICRIC ACID IN WAR SURGERY.

By Major T. F. BROON, D.S.O., A.A.M.

In considering the treatment of wounds received in action, one is struck with the many peculiarities undoubtedly existing due to the nature of the weapons and the position of the soldier when wounded. The many cases of tetanus supervening after wounds led an able surgeon in an admirable article in the *British Medical Journal* to advocate the use of pure carbolic acid as necessary to save life, or as a prophylactic against tetanus, notwithstanding the marked corroding effect and subsequent sloughing of the tissues with its concomitant lengthening of the convalescent period. It is interesting to note that many surgeons of the British Expeditionary Force in France still hold varied views on the question of the value of antiseptics in the treatment of war wounds.

Being desirous of writing but a short article, it is necessary not to refer to the treatment of foreign bodies, the pathology or principles of military surgery.

It was early in 1914 that I became acquainted with the fact that picric acid was four times more potent than carbolic acid in bacteriocidal properties, and from investigation found that one per cent solution kills strepto- and staphylococci in two minutes.

During the Gallipoli campaign, as Officer Commanding No. 1 Australian Auxiliary Hospital in Egypt, an opportunity presented itself to test its value practically in the treatment of over 3,000 wounded patients admitted. The medical officers and nursing staff carried out the following routine treatment as far as practicable:—

(1) To superficial wounds one per cent picric acid solution was applied on thin gauze. The wound was thus left practically exposed to the air; usually one dressing per day was sufficient.

(2) Suppurating sinuses were treated by syringing with five per cent to one per cent picric acid solution, twice daily, and H_2O_2 solution used every two or three days to remove debris.

(3) Arm and leg baths with five per cent solution for thirty minutes

were used for suppurating fractures and crushed tissues, with an occasional bath of hypertonic saline as a change.

The results were uniformly good. Healthy and vigorous granulation resulted and quick recovery. Several cases of septic compound fracture and injuries to bone cleared up in a remarkably short time.

Deep septic wounds caused by shrapnel, etc., granulated and were ready for skin grafting likewise. It must be noted, however, that we found 1 per cent solution too strong for the delicate epithelium of new skin, and weaker solutions, 0·5 per cent and 0·2 per cent, were used when the granulation reached the level of the surrounding epidermis. It may be mentioned here that a 0·2 per cent solution in water and spirits vini rect. was used in several cases of erysipelas with excellent results.

The opinions formed below of the properties and value of picric acid solution are based on the cases treated :—

(1) It kills bacteria without corroding effect and prevents suppuration.

(2) It stimulates granulation of the tissue.

(3) It has marked anodyne properties, and the need of aspirin or morphia was rare.

(4) By dispensing with hot fomentations, it saves much time, also cotton, wool lint, gutta percha tissue, etc.

(5) It is less irritating and more efficacious than iodine.

(6) It may be used for sterilization of the skin in surgical cases.

(7) It shortens the convalescent period.

The drawbacks usually mentioned are :—

(1) *Coagulation of the Tissue.*—This is so slight with the solutions used that it was unnoticeable, and we had no evidence of retardation in the healing of wounds from this cause.

(2) *Poisoning Effects.*—In the 3,000 cases treated not one showed any signs of poisoning. Moreover, I have painted a patient suffering from scarlet fever all over with a two per cent solution without any signs of absorption or poisoning, and believed that it hastened the peeling stage.

(3) *Discoloration of the Skin.*—This is very persistent, but the muscles and subcutaneous tissues apparently do not stain.

So far the opportunity has not presented itself to investigate the result of applying picric acid as a prophylactic in tetanus.

The number of septic wounds arriving at the base calls for more vigorous treatment in proximity to the scene of action. May I suggest that picric acid be stocked by all dressing stations, clearing hospitals and field ambulances if not already in use.

A useful form would be compressed tablets, which, when dissolved in one ounce of rectified spirit and nine ounces of water, would form a 2 per cent solution. If this is applied to all wounds on gauze as a first dressing, or when practicable the wound syringed with 1 per cent solution and then covered with gauze saturated with a 2 per cent solution, I am quite convinced that less sepsis, shorter convalescence and non-

effectiveness would be the result, and one which we should strive to attain, for the first duty ever before military surgeons is undoubtedly to consider (having afforded relief to the patient) the prognosis, which being interpreted means—How long will this man be away from the trenches?

In conclusion, I hope medical officers will thoroughly test the value of picric acid in this direction, and publish their results, for any treatment likely to shorten the period of absence of wounded men from the firing line is an important factor in prosecuting this War and bringing it to a successful conclusion.

NOTE ON A CASE OF ANASTOMOSIS BETWEEN FACIAL AND HYPOGLOSSAL NERVES.

By Captain R. H. STEVENS.
Royal Army Medical Corps.
Wharncliffe War Hospital, Sheffield.

The patient, a private in the Royal Fusiliers, was admitted on January 8, with a small wound over the right mastoid bone causing facial paralysis. He was wounded on December 24, 1915, and was unconscious for a few minutes after being hit. An X-ray plate showed a foreign body lying internal to the styloid process. As the wound was healing with no apparent improvement in the paralysed condition of the facial nerve, it was decided to cut down and ascertain the condition of affairs.

Operation.—January 21, by Major Graham Simpson, F.R.C.S., R.A.M.C. The sterno-mastoid was turned back from its mastoid origin, and a fissured fracture of the mastoid process was discovered. The process was chiselled away and a shell-splinter was found lying over the stylo-mastoid foramen, the facial nerve having been severed at its point of emergence. The distal end of the nerve was sought and secured with a ligature which was left protruding from the wound. This ended the first stage of the operation.

The muscles supplied by the facial showed hyperexcitability to galvanism, and, of course, a lack of response to faradism.

The second stage was performed on February 6, when the scar was reopened and the hypoglossal nerve isolated. The ligature had unfortunately slipped off the distal end of the facial, and considerable difficulty was experienced in finding it again in the substance of the parotid gland. The hypoglossal nerve was severed and its proximal end sutured to the distal end of the facial with chromic catgut, the point of junction being covered with a cuff of vein from the saphena. The wound was closed except for a small drain inserted on account of venous oozing. All the stitches were removed on February 20, and the only difficulty experienced by the patient was a slight impediment to speech and an inclination for food to collect in the right cheek.

At the moment of writing, seven months after the operation, there is a most satisfactory return of function in the muscles of expression. The patient can close his eye quite well and there is good voluntary contraction of all the muscles at the right angle of the mouth. He talks well and has overcome the difficulty with his food.

I am indebted to Major Graham Simpson for permission to publish this case, and to Mr. H. Caiger, F.R.C.S., who very kindly handed the case over to me.

THE CLINICAL MANIFESTATIONS OF GAS IN MILITARY MINES.

By Temporary Captain C. E. SUNDELL, M.D., M.R.C.P.
Assistant Physician to Seamen's Hospital, Greenwich.
Royal Army Medical Corps.

The following notes are mainly based upon a series of over 100 cases which have passed through my hands during the last few months. I have to acknowledge much valuable help in the study of this subject from Captain Logan, R.A.M.C., who has generously placed the results of his extensive experience at my disposal.

"Gassing" is responsible for the great bulk of casualties among miners, following the explosion of a charge. Military mining differs from industrial mining in three particulars which are of importance in the present connexion. The charges used are very much larger, the air space of the mine is very much smaller and adequate ventilation of the shafts and galleries is much more difficult to maintain. The harmful gas produced by an explosion may, for practical purposes, be regarded as consisting only of carbon monoxide; nitrous fumes are also present and may cause irritant effects in some cases, but these are relatively unimportant. The quantity of carbon monoxide produced by the explosion of a mine charge is considerable; if, as sometimes happens, the explosion is incomplete and part of the charge burns instead of detonating, the carbon-monoxide production is much increased. It is remarkable that in the area with which I am familiar more casualties occur during the few days subsequent to the explosion of a hostile mine than at the time of the explosion itself. This is to be explained by the friable nature of the chalky soil in which the mine is sunk; the force of the explosion fissures and shatters the soil throughout a wide zone, and in the crevices thus formed the gas collects till it is freed by fresh working, or puffed out into the galleries by gradual settling of the soil.

The following characters of carbon monoxide should be borne in mind: the gas is odourless, it does not affect a candle flame, its presence in the atmosphere at a strength of 0·1 per cent may be fatal, and its action is cumulative. Men may thus gradually come under its influence without any warning of its presence.

Premonitory Symptoms.—These may be absent; in many cases, however, warning is given by a feeling of heaviness and loss of power in the limbs, especially in the hands and arms; sometimes the first complaint is of giddiness or light-headedness. The loss of limb power is important, as it may prevent escape or lead to falls from the ladder while the man is attempting to climb out of the mine. All degrees of severity are met with, from transient disability to complete collapse and death: fortunately the cases of moderate severity are the most common.

Appearance of the Men.—Other observers lay stress upon the pink colour of cheeks and lips, and the appearance of cherry red patches upon the skin of the chest and back have been described; in my own cases, all of which have been seen without delay, pallor has been constant; a recent writer has called attention to the occasional late appearance of the classical pink tint in fatal cases of carbon-monoxide poisoning.

The attitude in the cases able to walk to the aid-post is very striking; it is that of extreme physical and mental fatigue. The men crouch on a bench with elbows on knees and supporting their heads on their hands; they show a great disinclination to speak or move. The mental state varies, however; sometimes considerable mental excitement is present, suggesting a thoroughly happy "drunk."

Pulse-rate.—In mild cases this is unaltered or slightly raised. In severe cases it may rise to 140 or more, while Captain Logan has told me of one case in which the patient was found unconscious and convulsed, with a pulse-rate of 38 to 42 beats per minute.

Temperature.—The patients even when only slightly affected are cold. This is partly due to the fact that they are brought thinly clad from the close atmosphere of a mine into the open air, but it is an established fact that carbon monoxide poisoning is always associated with lowering of the body temperature. In bad cases severe rigors may occur.

Respiration.—In mild cases this is slightly increased in rate; in severe cases it is slowed or abolished.

Vomiting is an almost constant symptom; it occurs usually when the man is brought out into the fresh air and it frequently affords relief to his feeling of weakness or giddiness.

Headache comes on usually on exposure to fresh air; it is often very severe and is usually frontal in position. It is one of the most lasting of the symptoms and may persist even in a mild case of poisoning for over seven days.

Præcordial pain is not a very common symptom. It may occur with palpitation and a throbbing headache. It has been found, however, in a good many cases, especially in men who have repeatedly been exposed to gas; in these men other phenomena of heart-fatigue may be present, such as superficial præcordial tenderness and undue breathlessness on exertion.

Nervous Phenomena.—Psychical or physical changes may ensue upon

repeated exposure to gas. Several men who originally possessed more than the average of pluck and determination have "lost their nerve" and developed insomnia, tremor of hands and weakness of will-power.

Treatment.—This may be summed up in warmth, oxygen, artificial respiration, rest. The lowering effect of CO upon the body temperature has been referred to; every effort should be made to provide warmth for these men with the least possible delay. Circulatory stimulants such as hot, strong coffee, are of great value.

Oxygen administration properly carried out is most beneficial; a well-fitting mask and a liberal amount of gas are necessary. It is possible that oxygen tends to wash out CO from the blood; whether this be so or not, it is a most valuable help towards recovery.

Artificial respiration should be carried out if circumstances allow by Schafer's method; this allows of continuous oxygen administration, and can be employed with the minimum of fatigue to the attendant. Prolonged and unremitting efforts may be necessary; I have seen recovery take place after two and three-quarter hours' apparently fruitless work. Some cases begin to breathe spontaneously after a time and then suddenly slip back and fail to respond to further efforts. Hypodermic injections of strychnine are of value in stimulating the respiratory centre.

Rest is essential; it should be absolute for at least twenty-four hours even in mild cases, and proportionately longer in the more severe.

Practical experience affords two warnings. Severe cardiac embarrassment has followed the taking of phenacetin and aspirin for the severe headache. The use of these drugs in these cases is now forbidden.

Men who have been slightly gassed should not be allowed to descend the shaft again till recovery is complete; the cumulative action of carbon-monoxide must never be forgotten.

Review.

WAR SHOCK. By M. D. Eder, B.Sc.London, L.R.C.P., M.R.C.S. London: William Heinemann. Pp. vii and 154. Price 5s. net.

This little book is based on the study of 100 cases of psycho-neuroses in soldiers while the author was in charge of the Psycho-Neurological Department, Malta. Shell shock was responsible for only fifty-three cases. In the classification of these cases the author has followed Freud, dividing them into three groups: Conversion hysteria, anxiety hysteria, and psychasthenia. In none of his cases did he make a diagnosis of neurasthenia. He introduces several interesting histories, illustrating the various types, and briefly covering the symptomatology of war-shock. The author is thoroughly imbued with the Freudian theory, and his book is full of the careless logic and the extreme dogmatism so characteristic of this new psycho-pathological school. He is given to much speculation

about the interpretation of soldiers' dreams that often have little or no significance. Certainly the average English clinician is inclined to be sceptical about the application of the Œdipus myth, and would undoubtedly be disgusted with reading a sex interpretation into the soldier's dream reported on p. 103. This soldier dreams of passing down a narrow river in a boat, gets stuck in the mud, and sees a fleet of balloons and a zeppelin. It appears that this refers to his birth—the narrow passage was his mother's vagina—the mud the perineum and anal region; the balloon is a uterus, and the zeppelin a phallus!

As to treatment, he prefers suggestion under hypnotism to any other method, but he has also employed simple suggestion, suggestion under an anæsthetic and psycho-analysis. Very few medical officers at present, in charge of a large number of wards, have time for psycho-analysis. Even Freud himself admits that it often takes months, with a daily conference of one hour, to get satisfactory results.

The author is more optimistic about prognosis than most physicians dealing with these cases, for, while a soldier may be discharged as cured, very few of us have an opportunity to follow up his subsequent history. Thus he states that six cases of "soldier's heart" were cured by hypnotic suggestion. Our experience with these men leads us to believe that they are repeatedly sent back to the hospitals for further treatment. For the physician interested in the psycho-neuroses of war, the book will furnish an interesting hour's reading, whether one agrees with the conclusions of the author or not.

W. H M.

Current Literature.

German Medical Congress at Warsaw. (Verhandlungen der ausserordentlichen Tagung des Deutschen Kongresses für innere Medizin in Warschau am 1 und 2 Mai, 1916.)

(*Continued from page* 507.)

(4) *Typhoid Fever.*—Generalarzt Krehl, commenting on the clinical aspect of typhoid fever as it had occurred in the German armies, remarked that the cases of typhoid fever met with on the Eastern Front had been characterized by a particularly free skin eruption, so that in this respect the cases had resembled cases of paratyphoid B fever. Enlargement of the spleen had been more frequent, and generally more marked in degree, than in cases which occurred formerly in times of peace. But he was under the impression that this more frequent enlargement of the spleen had occurred, during the War, in other diseases as well as in typhoid fever. Post-typhoid myocarditis had followed with noticeable frequency; but cerebral symptoms and pulmonary complications had not been more frequent than in peace time. Rheumatic symptoms and neuritis had not been uncommon, and cases thus complicated differed from the classical type of case of typhoid fever; but both class of cases occurred together amongst men of the same unit. The case mortality had been lower than in times of peace. All cases, whether of typhoid or paratyphoid infection, were described as enteric.

Diagnosis had been difficult sometimes in atypical cases—running their course in from four to eight days. Also there had been prolonged cases of typhoid fever, lasting for several months, which would justify description as "chronic typhoid fever." Dr. Krehl expressed himself with caution as to the value of treatment with vaccines, with convalescent serum, and with albumoses. Generalarzt Hünermann dealt with preventive inoculation, which was first enforced vigorously in October, 1914. But because of the movements of troops, and the urgency for intercurrent cholera inoculation, the process of antityphoid inoculation was delayed; it was not until January, 1915, or a little later, that the armies were fully protected. The vaccine used was sterilized by heating at a temperature between 53° and 55° C., and was standardized by opacity. It was polyvalent, being prepared from six strains of *Bacillus typhosus*. Amongst many millions of inoculations there had been only a single death from this cause. It had been found that the serum of the inoculated had an agglutination titre of 1 in 800, a fortnight or so after the last inoculation, in 40 per cent of 1,225 cases tested. The serum of rather more than fifteen per cent of the cases showed the same agglutination titre twelve months later. The agglutination test was held to be of little value in the diagnosis of typhoid infection in the inoculated. Even an increasing value in the agglutination titre must be regarded with suspicion, since in the inoculated such increase occurs in the course of fevers which are certainly not caused by typhoid infection. There had not been any increased risk of infection during the negative phase after inoculation. Investigation in 1,000 cases of typhoid fever occurring amongst the sanitary staff, amongst whom the risks of infection were fairly constant, did not suggest any increased liability to infection either during, or immediately after, inoculation. Dr. Hünermann believed that inoculation caused latent cases of typhoid infection to declare themselves. Use had been made of this in the inoculation of contacts with one cubic centimetre of the polyvalent vaccine; with the result that mild cases of typhoid fever which had escaped detection were identified. It was difficult to express the protective value of antityphoid inoculation in exact figures. The number of cases of typhoid fever in the field armies during 1914-15 was heavily in excess of the annual average of the five preceding peace years, and reached a rate of 1·5 per 1,000 in December, 1914. But this showed a great improvement on the prevalence of the disease in the campaign of 1870-71, when in October, 1870, the rate had already reached 21 per 1,000. In each of the two campaigns, however, there had been a rapid fall in prevalence after the maximum had been reached; and this fall had not been influenced by the practice of inoculation in the earlier campaign. In the present War the protective value of inoculation had been illustrated in Hindenburg's army in the East. In the earlier days of the fighting, protection against cholera was the first consideration, and only a few of his troops had been inoculated against typhoid infection by December, 1914; most of them were not inoculated until January or February, 1915. In January, 1915, the typhoid fever rate in this army had reached 2 per 1,000; in February the rate had fallen to 0·6 per 1,000, and although there was some slightly increased prevalence in the following autumn the rate never again exceeded 0·4 per 1,000. The following statistics were given with relation to the case mortality amongst the inoculated

and the uninoculated, and amongst the inoculated according to the number of injections given :—

	Percentage Case Mortality	
	Prisoners of war	German troops
Patients for whom information as to inoculation was not available	15·1 ..	14·3
Patients who had not been inoculated	13·8 ..	9·6
Patients inoculated, but number of inoculations unknown	10·8 ..	8·0
Patients who had been inoculated once	9·2 ..	8·7
,, ,, ,, twice	7·9 ..	6·6
,, ,, ,, three times ..	7·1 ..	5·3
Patients who had been inoculated more than three times	4·7 ..	2·6

Repeated inoculation had changed the clinical severity of the disease. The absolute number of deaths during October, November, and December, 1914, had been eight and one-half times as numerous as those during the same months of 1915. Since inoculation had been repeated, the severity of the symptoms of typhoid fever, as it occurred amongst the troops, had been diminished to a marked degree. With this diminished severity of the disease amongst the inoculated troops there had not been any diminution in its virulence amongst the unprotected civilian population, amongst whom the case mortality had been about seventeen per cent.

The time-duration of the protection afforded by inoculation had not been determined. But re-inoculation within six months did not appear to be necessary. It had been ascertained that the case mortality amongst those who contracted typhoid infection later than six months after inoculation was at the rate of 10·2 per cent, whilst the case mortality amongst those who became infected within three months after inoculation was at the rate of only 2·3 per cent.

(*To be continued.*)

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C.N. = Clinical and other Notes.
C.L. = Current Literature.

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of the

Royal Army Medical Corps

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January, 1917.

EXTRACTS FROM THE "LONDON GAZETTE."

November 23, 1916.

To be Companion of the Distinguished Service Order:—

Capt. (Temp. Major) Gerald Fitzgerald Rudkin, Royal Army Medical Corps.

War Office,
November 25, 1916.

His Majesty the King has been graciously pleased to approve of the appointments of the undermentioned Officers to be Companions of the Distinguished Service Order, in recognition of their gallantry and devotion to duty in the field:—

Major (Temp. Lieut.-Col.) Hugh Herbert James Fawcett, Royal Army Medical Corps.

For conspicuous gallantry in action and devotion to duty. He tended the wounded continuously for seventy-two hours. He has on many previous occasions done very fine work.

Temp. Capt. Donald Olson Riddel, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under intense fire, displaying the greatest courage and determination. Later, during a very heavy enemy bombardment, he walked up and down our trenches and administered to the wounded.

Capt. George Vincent Stockdale, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He led his stretcher-bearers continuously for five days, under very heavy fire, and on several occasions rescued wounded men by himself. He has on many previous occasions done very fine work.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field:—

Capt. Richard Andrew Austin, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination. He has previously done very fine work.

Capt. Robert Eric Barnsley, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty when in charge of an advanced dressing station. He tended the wounded under heavy hostile shell fire when impossible to bring them to the dressing station.

Temp. Capt. Tobias Rustat Hemsted Blake, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He dressed the wounded for seven hours in an open trench under very heavy fire. Later he tended the wounded in the open, displaying great courage and determination.

Temp. Lieut. George Bent Buckley, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination. He was wounded.

Temp. Capt. Leeming Anderson Carr, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He continually led stretcher-bearers under very heavy fire, and on many occasions he himself rescued wounded men. He set a splendid example of courage and determination.

Capt. Charles Leopold Franklin, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He personally led parties of stretcher-bearers under very heavy fire, successfully rescuing and evacuating the wounded. He showed great courage and determination throughout.

Temp. Capt. Robert Masson Greig, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He led a stretcher party under heavy fire, and personally superintended the collection and evacuation of the wounded for thirty hours. He displayed great courage and determination throughout.

Capt. Charles Frederick Hacker, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination. Later, he rescued a wounded officer from "No Man's Land" under very trying circumstances.

Capt. Richard William George Hingston, M.B., Indian Medical Service.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded continuously under very heavy fire at close range regardless of his own personal safety.

Temp. Capt. Patrick Joseph Lane, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He led parties of stretcher-bearers under heavy fire, displaying great courage and skill. He worked continuously for forty-eight hours, and was himself wounded. He set a splendid example to the men under him.

Temp. Capt. George Barbour Macgregor, M.B., R.A.M.C.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination. He has on many previous occasions done very fine work.

Temp. Lieut. Gerald James McGorty, M.B., R.A.M.C.
For conspicuous gallantry and devotion to duty. Although himself very severely wounded, he supervised the work of tending to five other wounded men. He displayed great courage and determination throughout.

Temp. Capt. Timothy Meagher, M.B., R.A.M.C.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination throughout the operations. He has on many previous occasions done very fine work.

Temp. Lieut. Douglas Macleod Moffatt, M.D., R.A.M.C.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination. He set a splendid example throughout.

Temp. Capt. William Morrison, M.B., R.A.M.C.
For conspicuous gallantry and devotion to duty. Although himself wounded, he tended and dressed the wounded under very heavy fire, displaying great courage and determination.

Temp. Capt. Basil Newman Murphy, R.A.M.C.
For conspicuous gallantry and devotion to duty. Although himself wounded, he tended and dressed the wounded under very heavy fire, displaying great courage and determination.

Capt. Arthur Herbert Norris, R.A.M.C.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination. He has done very fine work throughout the campaign.

Capt. Harold Gordon Oliver, R.A.M.C.
For conspicuous gallantry and devotion to duty. He organized and led stretcher parties under very heavy fire with great courage and determination.

Capt. John McCallum Orme, M.B., R.A.M.C.
For continuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination. Later, after his battalion had been relieved, he remained behind evacuating the wounded.

Temp. Capt. John McLean Pinkerton, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire with great courage and determination. He has previously done very fine work.

Temp. Lieut. Samuel Pool, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He led his bearers through a heavy fire and collected a number of wounded in the open. He worked continuously for forty-eight hours, displaying great courage and determination.

Temp. Capt. Charles Derwent Rye-Smith, M.B., F.R.C.S., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under intense fire throughout the operations with great courage and determination. He has on many previous occasions done very fine work.

Temp. Capt. William Russell, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded of four regiments under intense fire, displaying great courage and determination. He set a splendid example to all ranks.

Temp. Capt. John Caruthers Sale, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He rescued many wounded men under intense fire by carrying them on his back, displaying great courage and coolness. He set a splendid example throughout the operations.

Temp. Lieut. Malcolm Sommerville, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination.

Capt. Thomas Ainsworth Townsend, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination in rescuing several men who had been buried, under heavy fire. On three different occasions he had done very fine work.

Temp. Capt. John Wright Turner, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He worked incessantly by day and night bringing in wounded from shell-holes and attending them in dug-outs He displayed great determination and a total disregard of personal safety throughout.

Temp. Lieut. Reginald Fowke Williams, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He rescued a wounded man under very heavy fire. Later, although himself wounded, he continued to dress the wounded, displaying great courage and determination.

Temp. Capt. Eric Wordley, M.B., Royal Army Medical Corps, Devon Regt.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination. He set a splendid example throughout.

Temp. Lieut. Charles Stuart Wynne, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He worked all night tending and dressing the wounded in the open, thereby saving many lives. Later, he carried out his fine work continuously for three days.

Australian Imperial Force.

Capt. Douglas Dunbar-Jamieson, Army Medical Corps.
For conspicuous gallantry and devotion to duty. With two drivers and a man he went with a sandcart to the left flank. He rescued two wounded men and loaded them into the cart under intense fire. Later, he searched the front for more wounded men.

Capt. Geoffrey Hampden Vernon, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire, displaying great courage and determination. Later, he remained out all night with a wounded man.

Canadian Force.

Capt. Henry Harold Argue, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination throughout.

Capt. William Brown, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded continuously for forty-eight hours, under very heavy fire. He displayed great courage and determination throughout the operations.

Capt. Harold Wigmore McGill, Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire with great courage and determination.

New Zealand Force.

Capt. Ronald Graeme Scott Orbell, Medical Corps.
For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire with great courage and determination. On one occasion he carried two wounded men on his horse to safety.

The undermentioned has been awarded a second bar to his Military Cross for a subsequent act of conspicuous gallantry:—
Temp. Capt. William Howard Lister, M.C., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He led his stretcher-bearers under intense fire, dressing and evacuating the wounded. He displayed great determination and an utter disregard for his personal safety throughout the operations. (The Military Cross was awarded in the *London Gazette*, dated June 23, 1915. The first bar was awarded in *London Gazette*, dated October 20, 1916.)

The undermentioned has been awarded a bar to his Military Cross for subsequent acts of conspicuous gallantry:—
Temp. Capt. George D'Rastrik Carr, M.C., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. Although himself wounded, he continued to tend and dress the wounded, displaying great courage and determination throughout.
(The Military Cross was awarded in the *London Gazette*, dated February 2, 1916.)

Amendment.—The following correction is made in the *London Gazette* announcement dated November 14, 1916:—
For Temp. Capt. John Macintyre, M.B., Royal Army Medical Corps, *read* Temp. Lieut. John Macintyre, M.B., Royal Army Medical Corps.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officers and Men for acts of gallantry and devotion to duty in the field:—
No. 6870 Pte. M. Berry, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. With another private, he rescued two wounded men under very heavy fire, carrying one of them 150 yards across the open. Later, he worked for nine days with great courage and determination.
No. 195 Pte. C. Dilthey, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He rescued and dressed the wounded under intense fire throughout the operations, displaying great courage and determination. Later, although severely wounded, he continued to carry out his work.
No. 30334 Serjt. W. H. Gooding, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He organized and led stretcher-parties under very heavy fire, displaying great courage and determination. He set a splendid example throughout.
No. 1655 Corpl. W. Kidd, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He carried a wounded man into an open trench and stood over him to protect him from splinters for two hours. Later, he rescued several wounded men under very heavy fire.
No. 39140 Pte. T. McGinn, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and carried the wounded under intense fire continuously for thirty-six hours, displaying great courage and determination.
No. 38791 Pte. M. Thornton, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. With another private he rescued two wounded men under very heavy fire, carrying one of them 150 yards across the open. Later, he worked for nine days with great courage and determination.

EXTRACT FROM THE "LONDON GAZETTE," FRIDAY, DECEMBER 1, 1916.

General Headquarters,
October 13, 1916.

Sir,—In accordance with the final paragraph of my Dispatch, dated October 1, 1916, I have the honour to submit herewith the list of Officers and others whose services I desire to bring particularly to your attention.

I have the honour to be,
Your most obedient Servant,
A. J. Murray, *General,*
Commander-in-Chief, Egyptian Expeditionary Force.

Col. (Temp. Surg.-Gen.) J. Maher, C.B., Army Medical Service.
Major (Temp. Lieut.-Col.) P. S. Lelean, C.B., F.R.C.S., Royal Army Medical Corps.
Temp. Capt. A. S. M. Macgregor, M.D., Royal Army Medical Corps.
Temp. Lieut.-Col. H. L. Eason, M.D.
Local Lieut.-Col. L. P. Phillips, M.D.

Temp. Lieut.-Col. J. W. Barrett, C.M.G., late Lieut.-Col.
Major (Temp. Lieut.-Col.) E. McDonnell, M.B.
Capt. (Special Reserve) R. B. Campion.
Temp. Capt. T. D. Kennedy, M.B.
Temp. Lieut. M. Sommerville, M.B.
Temp. Capt. G. Wright, M.B., F.R.C.S.
Lieut.-Col. W. Howorth.
Capt. (Temp. Lieut.-Col.) J. W. Mackenzie, M.D.
Capt. C. C. Fitzgerald, M.C.
Capt. A. H. Norris.
Capt. N. H. H. Haskins, M.B.
Capt. A. B. Sloan, M.D.
Capt. R. S. Taylor, M.B.
Capt. F. J. Green, M.D.
Capt. J. H. Wood.
Capt. D. Dickie, M.B., F.R.C.S.Edin.
Qmr. and Hon. Lieut. G. R. Lougher.
Capt. (Temp. Maj.) A. H. Horsfall, D.S.O., M.B.
No. 18832 Staff-Serjt. G. Heard.
No. 33477 Cpl. J. W. Davies.
No. 37619 Pte. F. H. Kieff.
No. 27855 Pte. W. F. Bottomley.
No. 47629 Pte. J. A. Emery.
No. 106 Qmr.-Serjt. (acting Serjt.-Major) R. Clarke.
No. 698 Qmr.-Serjt. (acting Serjt.-Major) J. J. Abbott.
No. 1304 Staff-Serjt. G. Grant.
No. 489 Pte. (acting Staff-Serjt.) P. R. Fincher.
No. 332 Serjt. J. E. Coutts.
No. 1591 Serjt. F. W. Knight.
No. 1472 Serjt. W. Davidson.
No. 1804 Pte. (acting Lance-Cpl.) T. Jones.
No. 521 Pte. W. Humphries.
No. 1810 Bugler A. S. W. Powell.

War Office,
December 6, 1916.

The Secretary of State for War has received the following dispatch from Lieut.-Gen. G. F. Milne, C.B., D.S.O., commanding British Salonika Army:—

Headquarters, British Salonika Army,
October 8, 1916.

20. I desire specially to acknowledge the excellent work rendered by Surg.-Gen. H. R. Whitehead, C.B., and all ranks of the medical services under his command during a period in which sickness was prevalent. All branches of the Royal Army Medical Corps and the Canadian Army Medical Corps deserve the greatest commendation, and have fully maintained their high traditions of efficiency.

The medical services have been called upon to face problems of great difficulty. It can be easily realized that in a climate varying from severe cold to intense damp heat, and in a mountainous country deficient in water, poorly supplied with roads, without local resources, and where dysentery and malaria are rife, the duties and responsibilities of these services must necessarily be heavy.

Experiments as to the most efficacious types of mountain ambulance transport had been conducted in the winter and spring, and as a result travois, mule litters and cacolets now form integral portions of each field ambulance.

During the same period exhaustive measures were taken for an anti-malarial campaign. Officers with special knowledge were appointed to supervise anti-malarial work; swampy areas were drained, and the defensive lines then held carefully surveyed with a view to only the most healthy portions being held. Although malaria has still been the prevailing disease, yet I feel certain that these careful precautionary measures have been greatly instrumental in lessening its intensity. The move to the valley of the Struma in June tested all the preparations made, and severely tried the medical resources. The area occupied was found to be highly malarious, the heat intense and damp, and the single road from the base, long, hilly, and of uneven surface. The organization of this line of evacuation and the arrangement of halting places and refilling points was, however, successfully undertaken.

The work performed by the Motor Ambulance Convoys was invaluable. Running practically continuously, they succeeded in coping with the calls made upon them; difficulties were minimized by the forethought and energy displayed and the sick were transferred with satisfactory expedition to the Base hospitals.

The preparations for offensive operations on the Doiran front towards the end of July necessitated further developments in rearward medical services. Efficient ambulance railway trains were improvised from local rolling stocks, and a railway line of evacuation organized. From the eastern extremity of the British line of defence, evacuation by sea is the only feasible course. Three distinct systems are therefore in operation at one and the same time, by railway, by road and by sea, all converging on one base. When active operations commenced the rôles of the various forms of mountain ambulance transport organized for the field ambulances became apparent. On opening hillsides, along the beds of ravines, over slopes covered with scrubs, relay parties of stretcher-bearers, travois, litters, and cacolets, conveyed the wounded back to the dressing stations. The use of improvised methods in action shows vividly the special conditions under which the medical services of the Army have been called upon to work, and has necessitated the closest co-operation between staffs and medical units.

The advice of the consultant physicians and surgeons, and of the medical experts who have visited this army, has considerably aided in the maintenance of a high standard of technical efficiency. The close touch in matters of sanitation between the medical services of field formations, the staff, and unit commanders, has been of the greatest benefit in maintaining the health and comfort of the troops.

I cannot conclude my remarks on the medical services without paying testimony to the devoted service rendered by the nursing sisters belonging to the various hospitals. By their skill, care and attention, at a time of great stress under trying climatic conditions, the sufferings of the patients have been largely alleviated.

Army Medical Service.

Col. A. A. Sutton, D.S.O.
Col. M. P. C. Holt, C.B., D.S.O.
Col. G. T. Rawnsley, C.M.G.
Temp.-Col. J. P. Stewart, C.B., M.D., F.R.C.P., Capt. 4th London General Hospital. Royal Army Medical Corps, Territorial Force.
Temp.-Col. T. C. English, M.B., F.R.C.S., Capt. 4th London General Hospital, Royal Army Medical Corps, Territorial Force.

Royal Army Medical Corps.

Bt.-Col. (Temp. Col.) F. Smith, C.M.G., D.S.O.
Lieut.-Col. (Temp. Col.) P. MacKessack, M.B.
Lieut. Col. (Temp. Col.) W. H. S. Nickerson, V.C., C.M.G., M.B.
Lieut.-Col. A. R. Aldridge, C.S.I., M.B., Reserve of Officers.
Lieut.-Col. J. C. Connor, M.B.
Lieut.-Col. S. H. Withers, M.B.
Lieut.-Col. L. F. Smith, M.B.
Lieut.-Col. E. T. F. Birrell, C.M.G., M.B.
Lieut.-Col. M. M. Lowsley.
Lieut.-Col. F. Ashe.
Major (Temp. Lieut.-Col.) S. L. Pallant.
Major (Temp. Lieut.-Col.) C. W. Holden.
Major J. T. Johnson. M.D.
Major G. Ormrod, M.B.
Major E. L. Moss, M.C.
Major W. J. Weston.
Capt. (Temp. Major) P. S. Tomlinson.
Capt. (Temp. Major) R. E. Kelly, M.D., F.R.C.S., Royal Army Medical Corps, Territorial Force.
Capt. T. Carnwath, M.B.
Capt. W. R. Galwey, M.B.
Capt. C. T. Edmunds.
Capt. W. E. C. Lunn, M.B.
Capt. O. R. McEwen.
Capt. E. M. Middleton.

Capt. N. V. Lothian, M.B.
Capt. A. A. Atkinson, M.B., Special Reserve.
Capt. F. Crosbie, M.B., Special Reserve.
Temp. Capt. T. E. Parker, M.B.
Temp. Capt. J. F. Bourke.
Temp. Capt. D. Bell, M.B.
Temp. Capt. K. G. Fraser.
Temp. Capt. W. A. L. H. Henderson, M.B.
Temp. Capt. H. P. Hamilton, M.B.
Temp. Capt. G. B. Burwell, M.B.
Temp. Capt. R. S. Dewar.
Temp. Capt. R. A. Mansell, M.B.
Temp. Lieut. J. V. Grant, M.B.
Temp. Lieut. C. S. Dodson.
Temp. Lieut. H. F. Brice-Smith.
Temp. Qmr. and Hon. Lieut. E. E. Larner.
Temp. Qmr. and Hon. Lieut. W. Richardson.
No. 17910 Serjt. (Acting-Qmr.-Serjt.) W. Green.
No. 32611 Cpl. (Acting-Staff-Serjt.) G. Hughes.
No. 25893 Pte. (Acting-Cpl.) E. G. L'Estrange.
No. 56810 Serjt. J. W. Hunton.
No. 32620 Pte. (Acting-Serjt.) E. J. Ireson.
No. 39447 Serjt. P. le Lacheur.
No. 32477 Serjt. T. E. Slaney.
No. 7021 Pte. R. W. Tilly.
No. 32597 Pte. C. G. Stewart.
No. 33664 Pte. J. Charnock.
No. 71336 Pte. P. O'Keefe.
Lieut.-Col. J. R. Whait, M.B.
Capt. (Temp. Lieut.-Col.) H. G. G. Mackenzie, M.D.
Capt. (Temp. Lieut.-Col.) G. T. Willan.
Capt. (Temp. Major) T. H. Peyton, M.D.
Capt. R. E. Bickerton, M.B.
Capt. C. W. Greene, M.B., F.R.C.S.
Capt. R. M. Vick.
No. 2395 Serjt. A. H. Rogers.
No. 181 Corpl. Allen.
No. 318 Pte. J. P. Staig.
No. 2779 Pte. A. E. Ruel.

ARMY MEDICAL SERVICE.

Col. Bruce M. Skinner, C.M.G., M.V.O., to be Temp. Surg.-Gen. whilst employed as a Director of Medical Services, dated November 1, 1916.

The undermentioned Lieutenant-Colonels to be temporary Colonels whilst employed as Assistant Directors of Medical Services of a Division :—
October 30, 1916.—Standish de C. O'Grady, M.B.
November 2, 1916.—Harold P. W. Barrow.

Col. Herbert Eustace Cree is retained on the Active List under the provisions of Arts. 120 and 522, R. Warrant for Pay and Promotion, and to be supernumerary, dated November 27, 1916.

ROYAL ARMY MEDICAL CORPS.

Lieut.-Col. Ralph Holyoake is retained on the Active List under the provisions of Arts. 120 and 522, R. Warrant for Pay and Promotion, and to be supernumerary, dated November 26, 1916.

Major William Byam is restored to the establishment, dated November 6, 1916.

The date on which Lieut.-Col. George S. McLoughlin, C.M.G., D.S.O., M.B., relinquished his temporary rank is September 11, 1916, and not as in the *Gazette* or October 25, 1916.

The undermentioned Majors (Temporary Lieutenant-Colonels) relinquish their temporary rank on re-posting :—

Dated July 8, 1916.—John G. Bell, D.S.O., M.B.

Dated September 7, 1916.—H. S Peeke.

Dated November 10, 1916.—Major Harold S. Peeke (Res. of Off.), to be Temp. Lieut.-Col. whilst serving with No. 1 British Red Cross (Duchess of Westminster's) Hospital.

Major (temp. Lieut.-Col.) Rowland P. Lewis to be Temp. Lieut.-Col., January 6, 1916, and not as stated in the *Gazette* of October 13, 1916.

Qmr. and Hon. Capt. George A. Benson to be Temp. Hon. Major whilst employed in a Base Record Office, dated November 16, 1916.

War Office,
December 9, 1916.

The President of the French Republic has bestowed the decoration "Croix de Guerre" on the undermentioned Officer, in recognition of his distinguished service during the campaign :—

Temp. Capt. George Francis Palmer Heathcote, M.B., Royal Army Medical Corps.

There are no restrictions as to the occasion on which the decoration may be worn.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men :—

No. 35321 Serjt. L. Boyes, Royal Army Medical Corps.
No. 903 Serjt. E. A. Brownhill, Royal Army Medical Corps.
No. 36971 Serjt. G. W. Burrows, Royal Army Medical Corps.
No. 60205 Pte. D. Cadden, Royal Army Medical Corps.
No. 6771 Pte. R. J. Campbell, Royal Army Medical Corps.
No. 26385 Cpl. H. E. Chambers, Royal Army Medical Corps.
No. 1751 Pte. J. Clough, Royal Army Medical Corps.
No. 4063 Pte. H. E. Cole, Royal Army Medical Corps.
No. 34959 Cpl. (Acting-Serjt.) C. Crapper, Royal Army Medical Corps.
No. 44330 Pte. J. Cullen, Royal Army Medical Corps.
No. 45725 Pte. A. Cunningham, Royal Army Medical Corps.
No. 18518 Serjt. J. W. Darlington, Royal Army Medical Corps.
No. 31223 Pte. W. C. Davis, Royal Army Medical Corps.
No. 35430 Pte. F. Denman, Royal Army Medical Corps.
No. 1704 Pte. A. Draffin, Royal Army Medical Corps.
No. 54696 Pte. H. Fitzgerald, Royal Army Medical Corps.
No. 68250 Pte. J. Flexon, Royal Army Medical Corps.
No. 17320 Cpl. (Acting-Serjt.) W. Garnett, Royal Army Medical Corps.
No. 72117 Pte. A. C. Green, Royal Army Medical Corps.
No. 47317 Acting-Cpl. W. Hamilton, Royal Army Medical Corps.
No. 54578 R. W. Henderson, Royal Army Medical Corps.
No. 29470 Pte. A. Hodge, Royal Army Medical Corps.
No. 59634 Pte. W. Hopkins, Royal Army Medical Corps.
No. 42084 Pte. C. L. Hughes, Royal Army Medical Corps.
No. 1446 Pte. R. Hutton, Royal Army Medical Corps.
No. 2334 Pte. C. W. King, Royal Army Medical Corps.
No. 37147 Pte. F. Knapp, Royal Army Medical Corps.
No. 1659 Acting-Cpl. J. Loram, Royal Army Medical Corps.
No. 53868 Serjt. J. Lowe, Royal Army Medical Corps.
No. 1917 Lance-Cpl. (Acting-Cpl.) A. MacDonald, Royal Army Medical Corps.
No. 65812 Cpl. F. H. Mann, Royal Army Medical Corps.
No. 66717 Pte. S. F. Marsh, Royal Army Medical Corps.
No. 41075 Pte. W. McCormack, Royal Army Medical Corps.
No. 35258 Staff-Serjt. D. McKechnie, Royal Army Medical Corps.
No. 3393 Pte. W. McKinnie, Royal Army Medical Corps.
No. 34560 Cpl. K. McLennan, Royal Army Medical Corps.
No. 1813 Pte. E. Merrill, Royal Army Medical Corps.
No. 39636 Pte. J. Miller, Royal Army Medical Corps.
No. 8077 Pte. A. Mitchell, Royal Army Medical Corps.
No. 5692 Pte. A. E. Morey, Royal Army Medical Corps.
No. 41184 Acting-Serjt. J. Morton, Royal Army Medical Corps.
No. 15740 Pte. T. Mullin, Royal Army Medical Corps.

No. 2311 Pte. C. Norton, Royal Army Medical Corps.
No. 9755 Pte. T. O'Neill, Royal Army Medical Corps, Welsh R.
No. 39395 Pte. J. Palmer, Royal Army Medical Corps.
No. 1998 Serjt. E. Patrick, Royal Army Medical Corps.
No. 4415 Cpl. (Acting-Serjt.) N. McL. Pirret, Royal Army Medical Corps.
No. 41192 Pte. W. F. Quinn, Royal Army Medical Corps.
No. 412 Serjt. W. E. Rickard, Royal Army Medical Corps.
No. 19320 Qmr.-Serjt. H. A. Ritchie, Royal Army Medical Corps.
No. 1344 Serjt. T. Robbins, Royal Army Medical Corps.
No. 30976 Cpl. R. H. Robinson, Royal Army Medical Corps.
No. 4099 Pte. T. Rumble, Royal Army Medical Corps.
No. 1668 Cpl. B. E. Rust, Royal Army Medical Corps.
No. 1345 Pte. A. C Smith, Royal Army Medical Corps.
No. 37787 Serjt. J. Smith, Royal Army Medical Corps.
No. 26255 Cpl. O. Speechley, Royal Army Medical Corps.
No. 46705 Pte. R. Stevenson, Royal Army Medical Corps.
No. 1446 Serjt. T. A. Sullivan, Royal Army Medical Corps.
No. 56097 Pte. A. J. Tait, Royal Army Medical Corps.
No. 41382 Serjt. R. Tarbet, Royal Army Medical Corps.
No. 47212 Serjt. W. F. Tesseyman, Royal Army Medical Corps.
No. 50774 Pte. H. Thorp, Royal Army Medical Corps.
No. 1420 Serjt. W. Twyman, Royal Army Medical Corps.
No. 6819 Cpl. J. Walsh, Royal Army Medical Corps.
No. 6434 Pte. (Acting-Cpl.) T. Waterman, Royal Army Medical Corps.
No. 714 Pte. S. H. Webster, Royal Army Medical Corps.
No. 1630 Serjt. W. R. Wharf, Royal Army Medical Corps.
No. 39227 Pte. T. Whiston, Royal Army Medical Corps.
No. 583 Serjt. A. E. Willis, Royal Army Medical Corps.
No. 66848 Pte. F. Wood, Royal Army Medical Corps.
The undermentioned has been awarded a bar to his Military Medal:—
No. 2904 Cpl. G. Mossop, Royal Army Medical Corps.

The award of the Military Medal above-mentioned was published in the *London Gazette*, dated October 27, 1916.

No. 40988 Staff-Serjt. R. S. Gillespie, Royal Army Medical Corps.

The award of the Military Medal above mentioned was published in the *London Gazette*, dated November 9, 1916.

For No. 1270 Cpl. (Acting-Serjt.) F. G. Marralle, Royal Army Medical Corps, *read* No. 1270 Cpl. (Acting-Serjt.) F. G. Marrable, Royal Army Medical Corps.

For No. 9341 Pte. A. Stevington, Royal Army Medical Corps, *read* No. 9341 Pte. A. Skevington, Royal Army Medical Corps.

War Office,
December 14, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men:—

No. 1102 Serjt.-Major T. H. Armstrong, Royal Army Medical Corps.
No. M1/07416 Pte. (Acting-Serjt.) R. E. Burchell, Army Service Corps, Royal Army Medical Corps.
No. 233 Serjt. H. E. Crofts, Royal Army Medical Corps.
No. 42424 Pte. T. Cubbon, Royal Army Medical Corps.
No. 1641 Pte. D. V. Hambrook, Royal Army Medical Corps.
No. 2372 Cpl. (Acting-Serjt.) N. Heather, Royal Army Medical Corps.
No. 60 Pte. I. Hollings, Royal Army Medical Corps.
No. 88 Staff-Serjt. R. P. Lawson, Royal Army Medical Corps.
No. 1127 Pte. J. W. Nutting, Royal Army Medical Corps.
No. 38734 Pte. T. Paddison, Royal Army Medical Corps.
No. 70 Pte. A. Wallace, Royal Army Medical Corps.

War Office,
December 11, 1916.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned officer to be a Companion of the Distinguished Service Order in recognition of his gallantry and devotion to duty in the field:—

Canadian Force.

Major Philip Burnett, Army Medical Corps.

For conspicuous gallantry and devotion to duty. He took over the command of the bearers at the Front, and for forty-eight hours carried out his duties with great skill and determination under very heavy fire.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned officers and warrant officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Mark Blakiston Baines, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, displaying great courage and determination. He rescued several men who were buried. He has on many previous occasions done fine work.

Capt. Frederick William Brunken, Royal Army Medical Corps.

For conspicuous gallantry in action. He continuously went into the open under very heavy fire and attended to the wounded. He displayed great courage and determination throughout.

Temp. Capt. Arthur Barrett Cardew, M.B., F.R.C.S., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded under heavy fire throughout the action, displaying great courage and determination.

Temp. Capt. Ralph Annesley Fuller, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led stretcher-parties and tended the wounded under intense fire. He displayed great courage and determination throughout the operations.

Temp. Capt. Allen Coulter Hancock, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led a rescue party in the open under heavy fire, and rescued twenty-eight wounded men. He displayed great courage and determination throughout the operation.

Temp. Capt. Robert Welton Hogg, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. With a party of stretcher-bearers he searched the forward area under very heavy fire and brought in many wounded. He has previously done fine work.

Temp. Capt. Edmund Basil Jardine, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded continuously for three days and nights under heavy fire, displaying great courage and determination. He has done fine work throughout the campaign.

Temp. Capt. James La Fayette Lauder, D.S.O., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He repeatedly with different parties of stretcher-bearers searched the forward area under intense fire and brought in many wounded men. He has previously done fine work.

Capt. Robert Gerald McElney, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He led stretcher parties and worked in the open under heavy fire continuously for thirty-four hours. He set a splendid example of courage and determination.

Temp. Capt. Wilfred McFarlane, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led a stretcher party across "No Man's Land" and attended to the wounded. He worked unceasingly throughout the operations under heavy fire, and set a splendid example.

Temp. Capt. Henry Strawson Turner, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led stretcher parties and tended the wounded under intense fire. On one occasion he rescued eight wounded men in the open.

New Zealand Force.

Capt. Norman Henry Prior, M.C.

For conspicuous gallantry and devotion to duty. He went over the parapet and dressed a wounded man under intense fire. Later he worked continuously among the wounded under fire, displaying great courage and determination.

The undermentioned has been awarded a bar to his Military Cross for subsequent acts of conspicuous gallantry :—

Temp. Capt. James Henry Fletcher, M.C., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He led parties of stretcher-bearers in the open under heavy fire. He displayed great courage and determination throughout the operations. (The Military Cross was awarded in the *London Gazette* dated January 4, 1916.)

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the under-mentioned non-commissioned officer for acts of gallantry and devotion to duty in the Field :—

No. 2118 Lance-Cpl. C. F. M. Tolman, Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. With three bearers he dressed a wounded officer in the open. Later, although himself severely wounded, he assisted to carry the officer 200 yards under fire.

War Office,
December 15, 1916.

DISTINGUISHED CONDUCT MEDAL.

His Majesty the King has been graciously pleased to award the Distinguished Conduct Medal to the undermentioned men in recognition of their distinguished service and devotion to duty during the spring and summer of last year in the Prisoners of War Camp at Gardelegen, Germany :—

No. 12672 Pte. W. T. D. Bristow, Royal Army Medical Corps (formerly Royal Fusiliers).
No. 12673 Pte. L. J. Simpson, Royal Army Medical Corps (formerly Royal Fusiliers).

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

CHANCERY OF THE ORDER, ST. JOHN'S GATE, CLERKENWELL, LONDON, E.C.
December 1, 1916.

The King has been graciously pleased to sanction the following promotions in and appointments to the Order of the Hospital of St. John of Jerusalem in England :—

As Knights of Grace.

Col. Sidney Maynard Smith, M.B., F.R.C.S., A.M.S.
Surg.-Gen. Richard William Ford, C.B., D.S.O., M.R.C.S.

ROYAL ARMY MEDICAL COLLEGE.

LIST OF BOOKS ADDED TO THE LIBRARY DURING THE MONTHS OF OCTOBER, NOVEMBER AND DECEMBER, 1916.

Title of Work and Author	Edition	Date	How obtained
A Treatise on Chemistry. By Roscoe and Schoslemmer. Vol. iii. Parts ii, iii, iv, and vi	Revised	1890-92	Library Grant.
Journal of Bacteriology. Official Organ of the Society of American Bacteriologists. Vol. i		1916	,, ,,
Les Fièvres Paratyphoïdes. Par Jacques Carles ..		1916	,, ,,
Commonwealth of Australia. Quarantine Service. Service Publication No. 7. Asiatic Cholera. By J. S. C. Elkington, M.D.		1916	Editor, Journal.
Service Publication No. 8. Notes on Classification of Common Rodents. By H. A. Longman		1916	,, ,,
Service Publication No. 10. An Analysis of the causes of Invalidity in respect of Claims under the Invalid and Old-age Pensions Act. By J. H. L. Compton, M.D.		1916	,, ,,
Service Publication No. 11. Report on Cancer Research. By A. H. Thwaites		1916	,, ,,
Report of the Director-General of Public Health, New South Wales, for the year ended December 31, 1914		1916	,, ,,
Localization by X-rays and Stereoscopy. By Sir J. Mackenzie Davidson		1916	,, ,,
The Treatment of Diseases of the Skin. By W. K. Sibley	2nd	1916	,, ,,
The Story of a Red Cross Unit in Serbia. By James Berry, F. M. D. Berry, and W. L. Blease		1916	,, ,,
A Compendium of Aids to First-Aid. By N. C. Fletcher	3rd	1916	,, ,,
A Short Course of First-Aid in Accidents. By Sir John Collie and Major C. F. Wightman		1916	,, ,,
The Biology of Tumours. By C. Mansell Moullin		1916	,, ,,
An Outline of Theosophy. By C. W. Leadbeater ..		1916	,, ,,
The Student's Text-book of Surgery. By H. Norman Barnett		1916	Commandant's Office.
Annual Report of the Sanitary Commissioner with the Government of India for 1914		1916	India Office.
Journal of the Royal Naval Medical Service, October		1916	The Editor.
The Fauna of British-India Series. Coleoptera. Rhynchophora-Curculionidæ. By Guy A. K. Marshall		1916	Secretary of State for India in Council.
Beiträge zur klinischen Chirurgie. Bd. xcviii, H. 3; Bd. xcix, H. 3; Bd. 100, H. 1 and 2		1916	War Office.
Mitteilungen der Deutschen Gesellschaft zur Bekämpfung der Geschlechtskrankheiten. Bd. xiv, Nos. 3 u. 4.		1916	,, ,,
Der Krieg und die Bekämpfung der Geschlechtskrankheiten. Von Hofrat Prof. Dr. E. Finger		1916	,, ,,
Dienst der Pestbestrigding. Verslag Over Het Tweede, Kwartaal, 1915		1915	,, ,,
Der Starrkrampf seine Entstehung und Behandlung. Von Prof. Dr. Ferdinand Blumenthal		1914	,, ,,
Military Surgery. By Dunlop P. Penhallow ..		1916	Director-General, A.M.S.

List of Books added to the Library—*Continued.*

Title of Work and Author	Edition	Date	How obtained
Exercise in Education and Medicine. By R. Tait McKenzie	2nd	1915	Presented by Surgeon-General M. W. Russell, C.B., A.M.S.
Nerve Injuries and their Treatment. By Purves Stewart and Arthur Evans		1916	,, ,,
Gunshot Roentgenograms taken in Constantinople during the Turco-Balkan War, 1912-1913. By Clyde S. Ford		1916	,, ,,
The Balkan Wars, being Lectures delivered at the Army Service Schools, Fort Leavenworth, Kansas. By Clyde S. Ford, Major, Medical Corps, U.S.A.		1915	,, ,,
La Guerre en Bulgarie et en Turquie. Onze Mois de Campagne. Par Le Professeur Dr. Octave Laurent		1914	,, ,,
La Mesure des Impotences par la Methode Egographique. Par Le Dr. Vallée		1916	,, ,,
Illustrations of the Zoology of South Africa. By Andrew Smith, M.D., Deputy Inspector of Army Hospitals. 4 vols. (Rare work)		1849	Presented by A. S. Michie, Esq. (Nephew of the Author).
The Streptotrichoses and Tuberculosis (being the Milroy Lectures for 1910). By Alexander G. R. Foulerton, F.R.C.S.		1910	Presented by the Author.
Newspaper Cuttings on the Subject of the Rank of Army Medical Officers. Arranged by Col. William Johnston, C.B., A.M.S. 5 vols.		1887-1907	Presented by Mrs. C. Johnston, Newton Dee, Murtle, Aberdeen.
Metropolitan Water Board. Tenth Annual Report. By Dr. A. C. Houston		1916	Presented by Dr. A. C. Houston.
Twelfth Report on Research Work. By Dr. A. C. Houston		1916	,, ,,

EXCHANGES, &c.

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Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

All such Communications or Articles accepted and published in the "Journal of the Royal Army Medical Corps" will (unless the Author notifies at the time of submission that he reserves the copyright of the Article to himself) become the property of the Library and Journal Committee, who will exercise full copyright powers concerning such Articles.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W.

Communications have been received from Colonel C. M. Wenyon; Lieutenant-Colonel J. H. Neil; Major G. H. Colt; Major E. L. Fyffe; Captain J. Carroll, Lieutenant C. E. L. Burman.

The following publications have been received :—

British : Air, The Journal of State Medicine, The Medical Press and Circular, The Lancet, The Journal of Tropical Medicine and Hygiene, The Hospital, The Royal Engineers' Journal, The St. Thomas's Hospital Gazette, The Medical Review, St. Bartholomew's Hospital Journal, The Medical Journal of Australia, Annals of Tropical Medicine and Parasitology, The Liverpool Medico-Chirurgical Journal, British Journal of Tuberculosis, Public Health, Tropical Veterinary Bulletin, Army Service Corps Journal, The South African Institute for Medical Research, Tropical Diseases Bulletin, The Practitioner, Proceedings of the Royal Society of Medicine, The India Journal of Medical Research, Transactions of the Society of Tropical Medicine and Hygiene.

Foreign : Bulletin de l'Institut Pasteur, The Journal of Infectious Diseases, Norsk Tidsskrift for Militaermedicin, Office International d'Hygiène Publique, Bulletin of the Johns Hopkins Hospital, Russian Naval Medical Journal, Militaerlaegen, The Military Surgeon, Le Caducée, Annali di Medecina Navale e Coloniale, Archives de Médecine et de Pharmacie Militaires, Bulletin de la Société de Pathologie Exotique, L'Ospedale Maggiore, Tidskrift i Militär Hälsovard, Archives de Médecine et Pharmacie Navales, Giornale di Medicina Militare.

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

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The Hon. Manager,
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War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

February, 1917.

BRITISH SALONIKA FORCE.

General Headquarters,
British Salonika Force,
December 1, 1916.

Honours and Rewards.

Under authority granted by His Majesty the King to the Lieutenant-General Commanding-in-Chief, the following honours have been awarded for gallantry in the Field and devotion to duty, dated December 1, 1916:—

Distinguished Conduct Medal.

No. 2100 Serjt. Earl Brett Trotter, 1st Home Counties Field Ambulance, Royal Army Medical Corps (Territorial Force).

Military Medal.

No. 32276 Pte. (Acting-Serjt.) Thomas Boyd, Royal Army Medical Corps.
No. 243 Staff-Serjt. Alfred Sparkes, 2 1st City of London Field Ambulance, Royal Army Medical Corps (Territorial Force).

Meritorious Service Medal.

No. 12052 Staff-Serjt. (Acting Staff-Serjt-Major) Frederick Cuthbert Halkett, Royal Army Medical Corps.
No. 27258 Serjt. Major Josiah Perkins Bent, Royal Army Medical Corps.
No. 6231 Serjt. (Acting Serjt.-Major) William Stokes, Royal Army Medical Corps.
No. 39480 Staff-Serjt. (Acting Qmr.-Serjt.) Frank Finton Turner, Royal Army Medical Corps.
No. 14888 Staff-Serjt. Herbert Currell, Royal Army Medical Corps.
No. 53046 Serj. Joseph Sydney Bowring, Royal Army Medical Corps.
No. 53437 Serjt. John Graham, Royal Army Medical Corps.
No. 933 Qmr.-Serjt. (Acting Serjt.-Major) Douglas George Maher, 2nd Home Counties Field Ambulance, Royal Army Medical Corps (Territorial Force).
No. 1042 Staff-Serjt. William Henry George Greenfield, 1st London Sanitary Company, Royal Army Medical Corps (Territorial Force).
No. 32 Staff-Serjt. Herbert James, 2nd City of London Field Ambulance, Royal Army Medical Corps (Territorial Force).
No. 380 Serjt. Frank Stanley Greenslade, 3rd London Field Ambulance, Royal Army Medical Corps (Territorial Force).

Granard, *Lieut.-Col.*,
Assistant Military Secretary to Commander-in-Chief,
British Salonika Force.

EXTRACTS FROM THE "LONDON GAZETTE."

War Office,
December 21, 1916.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men :—

No. 1600 Pte. J. R. Anderson, Royal Army Medical Corps.
No. 32142 Pte. J. G. Atkinson, Royal Army Medical Corps.
No. 37307 Serjt. J. Barnett, Royal Army Medical Corps.
No. 10647 Acting-Cpl. F. W. Bond, Royal Army Medical Corps.
No. 36811 Pte. C. W. J. Branch, Royal Army Medical Corps.
No. 39410 Pte. F. H. Burgess, Royal Army Medical Corps.
No. 31658 Serjt. J. Corbishley, Royal Army Medical Corps.
No. 45730 Serjt. A. Crookston, Royal Army Medical Corps.
No. 37710 Pte. F. Daniels, Royal Army Medical Corps.
No. 56658 Pte. J. Davies, Royal Army Medical Corps.
No. 46707 Acting-Cpl. J. E. Davies, Royal Army Medical Corps.
No. 56659 Pte. T. E. Davies, Royal Army Medical Corps.
No. 1774 Pte. E. F. Dennis, Royal Army Medical Corps.
No. 20331 Pte. R. Fairless, Royal Army Medical Corps.
No. 1816 Pte. T. French, Royal Army Medical Corps.
No. 1614 Pte. H. Gibson, Royal Army Medical Corps.
No. 31822 Pte. R. Gill, Royal Army Medical Corps.
No. 1424 Pte. A. Goodhew, Royal Army Medical Corps.
No. 20701 Pte (Acting-Lance-Cpl.) W. Hampson, Royal Army Medical Corps.
No. 1559 Serjt. C. R. Hancock, Royal Army Medical Corps.
No. 34671 Cpl. R. Hannigan, Royal Army Medical Corps.
No. 39762 Acting-Cpl. J. H. D. Henderson, Royal Army Medical Corps.
No. 38666 Pte. E. Hickling, Royal Army Medical Corps.
No. 36949 Pte. E. G. Howells, Royal Army Medical Corps.
No. 48981 Pte. W. James, Royal Army Medical Corps.
No. 1820 Pte. T. F. Johnson, Royal Army Medical Corps.
No. 47978 Pte. W. Johnson, Royal Army Medical Corps.
No. 38191 Pte. D. Kirbyson, Royal Army Medical Corps.
No. 45626 Pte. F. R. Knocker, Royal Army Medical Corps.
No. 37535 Pte. W. F. Lawes, Royal Army Medical Corps.
No. 32266 Pte. A. M. McDonnell, Royal Army Medical Corps.
No. 9970 Cpl. F. Meerten, Royal Army Medical Corps.
No. 38906 Pte. D. P. Miller, Royal Army Medical Corps.
No. 36420 Serjt. B. E. Pearce, Royal Army Medical Corps.
No. 39392 Pte. E. Plimmer, Royal Army Medical Corps.
No. 45473 Pte. J. F. Pout, Royal Army Medical Corps.
No. 58148 Pte. (Acting-Cpl.) F. Reynolds, Royal Army Medical Corps.
No. 30818 Pte. J. Rimmer, Royal Army Medical Corps.
No. 37275 Pte. E. Sayers, Royal Army Medical Corps.
No. 1688 Lance-Cpl. J. A. Sellick, Royal Army Medical Corps.
No. 40222 Serjt. D. Semple, Royal Army Medical Corps.
No. 38431 Pte. L. T. Stanton, Royal Army Medical Corps.
No. 32983 Pte. A. Stockburn, Royal Army Medical Corps.
No. 1223 Pte. A Suckling, Royal Army Medical Corps.
No. 37261 Pte. H. T. Sutcliffe, Royal Army Medical Corps.
No. 45797 Pte. J. G. Sweeting, Royal Army Medical Corps.
No. 692 Serjt. E. Taylor, Royal Army Medical Corps.
No. 38472 Pte. H. Taylor, Royal Army Medical Corps.
No. 50781 Pte. (Acting-Lance-Cpl.) J. Taylor, Royal Army Medical Corps.
No. 33393 Pte. L. W. Tingle, Royal Army Medical Corps.
No. 82338 Pte. W. Tomlinson, Royal Army Medical Corps.
No. 1897 Pte. F. Valder, Royal Army Medical Corps.
No. 39189 Pte. J. E. Webb, Royal Army Medical Corps.
No. 1909 Pte. D. J. White, Ambulance Royal Army Medical Corps.
No. 37396 Pte. A. Wilkinson, Royal Army Medical Corps.
No. 44761 Pte. T. C. Williscroft, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers and Warrant Officers, in recognition of their gallantry and devotion to duty in the field:—

Temp. Capt. Walter Eustace Adam, M.C., M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in dressing and evacuating wounded under heavy fire.

Temp. Capt. Henry St. Arnaud Agate, Royal Army Medical Copps.

For conspicuous gallantry and devotion to duty. He attended to men who had been buried under intense fire. On another occasion he dressed the wounded of two battalions, working continuously for seventeen hours under fire.

Capt. Robert Burgess, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He worked at the advanced dressing station continuously for seventy-two hours, exposing himself fearlessly, and although wounded refused to be relieved, and remained at duty.

Capt. William Hunt, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He extinguished a fire in a bomb store at great personal risk, removing two boxes of burning bombs and undoubtedly saving many lives.

Temp. Lieut. John Woollaston Wayte, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He organized and led stretcher parties under intense fire. On several occasions he rescued wounded men in the open by carrying them on his back. He has previously done fine work.

Canadian Contingent.

Capt. George Garnet Greer, Canadian Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded for two hours in the open under intense fire. Later he worked continuously for forty-eight hours, and by his courage and devotion to duty was a splendid example to his men.

The undermentioned have been awarded a Bar to their Military Cross for subsequent acts of conspicuous gallantry:—

Temp. Capt. David Duncan Craig, M.C., M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended the wounded throughout the operations with great courage and skill, frequently passing through enemy barrages and going into the open. He set a splendid example. (The award of the Military Cross was published in the *London Gazette*, dated June 23, 1915.)

Temp. Capt. Ivan Clarkson Maclean, M.C., M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded continuously throughout the operations under very heavy fire, displaying great courage and determination. (The award of the Military Cross was published in the *London Gazette*, dated June 23, 1915.)

Central Chancery of the Orders of Knighthood.

Lord Chamberlain's Office,
St. James's Palace, S.W.
December 22, 1916.

The King has been graciously pleased to give orders for the following promotion in, and appointment to, the Most Honourable Order of the Bath, for services rendered in connexion with military operations in the Field in Mesopotamia. The promotion and appointment to date from June 3, 1916:—

To be Additional Member of the Military Division of the Third Class, or Companion of the said Most Honourable Order:—

Lieut.-Col. Gerard Beatty Irvine, Indian Medical Service.

Chancery of the Order of St. Michael and St. George.

Downing Street,
December 22, 1916.

The King has been graciously pleased to give directions for the following appointment to the Most Distinguished Order of St. Michael and St. George, for services rendered in connexion with military operations in the Field in Mesopotamia, to be dated June 3, 1916:—

To be Additional Member of the Third Class, or Companion of the said Most Distinguished Order:—

Col. Alan Edmondson Tate, Army Medical Service.

India Office,
December 22, 1916.

The King has been graciously pleased to make the following appointment to the Most Eminent Order of the Indian Empire, for services rendered in connexion with military operations in the Field in Mesopotamia, the appointment to date from June 3, 1916:—

To be Additional Companion of the said Most Eminent Order:—

Major William Gillitt, Indian Medical Service.

War Office,
December 22, 1916.

His Majesty the King has been graciously pleased to approve of the undermentioned Honours and Rewards for distinguished service in the Field in Mesopotamia, with effect from June 3, 1916, inclusive:—

To be Brevet-Colonel.

Lt.-Col. (Temp. Col.) D. J. Collins, M.D., Royal Army Medical Corps.

To be Brevet-Lieutenant-Colonels.

Major H. J. Crossley, Royal Army Medical Corps.
Major J. G. Foster, M.B., Royal Army Medical Corps.
Major C. M. Goodbody, D.S.O., Indian Medical Service.
Major J. H. Horton, D.S.O., M.B., Indian Medical Service.

To be Brevet-Majors.

Capt. F. T. Dowling, M.B., Royal Army Medical Corps.
Capt. T. J. Mitchell, M.B., Royal Army Medical Corps.

Awarded the Distinguished Service Order.

Capt. Wm. Haywood Hamilton, F.R.C.S., Indian Medical Service.
Capt. Robert de Stretton Berkeley Herrick, Indian Medical Service.
Major Robert Kelsall, M.B., Indian Medical Service.
Temp. Capt. Allan Noel Minns, M.C., Royal Army Medical Corps.
Capt. Robert Sweet, M.B., Indian Medical Service.

Awarded the Military Cross.

Temp. Capt. Robert Marshall Allan, M.B., Royal Army Medical Corps.
Capt. Desmond Charles Villiers FitzGerald, Indian Medical Service.
Capt. Herbert Leslie Garson, Royal Army Medical Corps (Special Reserve).
Capt. Alexander Glen, M.B., Royal Army Medical Corps (Special Reserve).
3rd Class Sub. Assist. Surg. Gopi-Nath Agarwal, I.S.M.D.
Capt. Edward Slade Goss, Indian Medical Service.
Capt. James Hall Hislop, M.B., Indian Medical Service.
4th Class Asst. Surg. John Dougald Malcolm Lamond, I.S.M.D.
Temp. Lieut. Walter George MacDonald, M.B., Royal Army Medical Corps.
Capt. Robert Forrester Douglas MacGregor, M.B., Indian Medical Service.
Capt. William Henry O'Riordan, Royal Army Medical Corps.
Capt. Dewan Hakumat Rai, M.B., Indian Medical Service.
Asst. Surg. James Michael Rodrigues, I.S.M.D.
Capt. Harold Kirby Rowntree, M.B., Indian Medical Service.
Capt. Jyoti Lal Sen, M.B., Indian Medical Service.
Temp. Lieut. Sundar Das Sondhi, M.B., Indian Medical Service.
Temp. Lt. Joseph Bulmer Thackeray, Royal Army Medical Corps.

Central Chancery of the Orders of Kighthood.

Lord Chamberlain's Office,
St. James's Palace, S.W.
January 1, 1917.

The King has been graciously pleased to give orders for the following promotions in, and appointments to, the Most Honourable Order of the Bath, for valuable services rendered in connexion with Military operations in the field:—

To be additional member of the Military Division of the Second Class, or Knights Commanders, of the said Most Honourable Order:—

Surg.-Gen. Hayward Reader Whitehead, C.B., F.R.C.S.

To be additional members of the Military Division of the Third Class, or Companions, of the said Most Honourable Order:—

Col. (Temp. Surg.-Gen.) James Murray Irwin, M.B., late Royal Army Medical Corps.
Col. Robert Lockhart Ross Macleod, M.B., Army Medical Service.
Col. Gerald Cree, C.M.G., Army Medical Service.
Col. Alexander Arthur Sutton, D.S.O., Army Medical Service.
Col. George Henry Barefoot, C.M.G., Royal Army Medical Corps.
Temp. Col. Thomas Sinclair, M.D., F.R.C.S., Army Medical Service.
Lieut.-Col. Edwin Thomas Fairweather Birrell, C.M.G., M.B., Royal Army Medical Corps.

CANADIAN CONTINGENT.

Col. Herbert Stanley Birkett, Canadian Army Medical Corps.
Col. James Alexander Roberts, Canadian Army Medical Corps.

Chancery of the Order of St. Michael and St. George,
Downing Street,
January 1, 1917.

The King has been graciously pleased to give directions for the following promotions in, and appointments to, the Most Distinguished Order of St. Michael and St. George, for services rendered in connexion with Military Operations in the Field:—

To be Additional Members of the Second Class, or Knights Commanders, of the said Most Distinguished Order:—

Surg.-Gen. Richard William Ford, C.B., D.S.O.
Col. Maurice Percy Cue Holt, C.B., D.S.O., Army Medical Service.

To be Additional Members of the Third Class, or Companions, of the said most Distinguished Order:—

Col. Thomas Daly, Royal Army Medical Corps.
Col. William Lewis Gray, M.B., Royal Army Medical Corps.
Col. Foster Reuss Newland, M.B., Army Medical Service.
Col. Henry Thomas Knaggs, M.B., Army Medical Service.
Col. Herbert Innes Pocock, Royal Army Medical Corps.
Col. Bertal Hopton Scott, Royal Army Medical Corps.
Col. Robert Wallace Wright, M.B., Royal Army Medical Corps.
Col. Thomas du Bedat Whaite, M.B., Royal Army Medical Corps.
Col. Frederick James Morgan, Army Medical Service.
Temp. Col. Thomas Crisp English, M.B., F.R.C.S., Army Medical Service.
Lieut.-Col. Arthur Russell Aldridge, C.S.I., M.B., Reserve of Officers, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) John David Ferguson, D.S.O., Royal Army Medical Corps.
Lieut.-Col. Samuel Henry Withers, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Ferberd Richard Buswell, Royal Army Medical Corps.
Lieut.-Col. Lionel Fergus Smith, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Frank Albert Symons, D.S.O., M.B., Royal Army Medical Corps.
Temp. Lieut.-Col. Gordon Morgan Holmes, M.D., Royal Army Medical Corps.
Temp. Lieut.-Col. Herbert Lightfoot Eason, M.D., Royal Army Medical Corps.

AUSTRALIAN IMPERIAL FORCE.

Lieut.-Col. Alfred Sutton, Australian Army Medical Service.

CANADIAN CONTINGENT.

Lieut.-Col. Edward Charles Hart, Canadian Army Medical Corps.

India Office,
January 1, 1917.

The King has been graciously pleased to make the following promotion in, and appointment to, the Most Eminent Order of the Indian Empire:—

To be Companions of the said Most Eminent Order:—

Lieut.-Col. James Graham Hojel, M.B., Indian Medical Service, Officer Commanding Lady Hardinge War Hospital, Bombay.

War Office,
January 1, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for Distinguished Service in the field, dated January 1, 1917:—

To be Brevet-Colonel.

Lieut.-Col. H. H. Norman, M.B., Royal Army Medical Corps.

To be Brevet Lieutenant-Colonels.

Major G. Ormrod, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) E. Ryan, D.S.O., Royal Army Medical Corps.

To be granted the next Higher Rate of Pay under Article 241 of the Royal Warrant.

Temp. Qmr. and Hon. Lieut. F. Richardson, Royal Army Medical Corps.
Qmr. and Hon. Lieut. C. Drury, Royal Army Medical Corps.

Awarded the Distinguished Service Order.

Capt. Robert George Archibald, M.B., Royal Army Medical Corps, employed in Egyptian Army.
Capt. Frank Rhodes Armitage, M.B., Royal Army Medical Corps.
Lieut.-Col. Marcus Hill Babington, Royal Army Medical Corps.
Capt. (Temp. Major) Winfred Kelsey Beaman, Royal Army Medical Corps.
Capt. Frederick Arnet Bearn, M.C., M.B., Royal Army Medical Corps, Special Reserve.
Major (Temp. Lieut.-Col.) William Bennett, M.B., Royal Army Medical Corps.
Lieut.-Col. William Arthur Benson, Royal Army Medical Corps.
Capt. (Temp. Major) Reginald Ernest Bickerton, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Elliot Beverly Bird, Royal Army Medical Corps.
Major Robert Barclay Black, M.B., Reserve of Officers, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Robert James Blackham, C.I.E., F.F.P.S., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Ernest William Bliss, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) John Handfield Brunskill, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Ronald Anderson Bryden, Royal Army Medical Corps.
Capt. Hector Mackay Calder, M.B., Royal Army Medical Corps.
Lieut.-Col. Frederick Fitzgerald Carroll, M.B., Royal Army Medical Corps.
Lieut.-Col. Robert William Clements, M.B., Royal Army Medical Corps.
Lieut.-Col. Harold Collinson, M.B., F.R.C.S., Royal Army Medical Corps.
Major John Marcus Hobson Conway, F.R.C.S.I., Royal Army Medical Corps.
Capt. Myer Coplans, M.D., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Hugh Allan Davidson, M.B., Royal Army Medical Corps.
Capt. David Dickie, F.R.C.S., Royal Army Medical Corps.
Capt. (Temp. Major) Gilbert Henry Dive, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Henry Mason Dunn, M.B., Royal Army Medical Corps.
Capt. (Temp. Major) Georgie Bennick Edwards, Royal Army Medical Corps.
Lieut.-Col. Otto William Alexander Elsner, Royal Army Medical Corps.
Major Henry Horace Andrews Emerson, M.B., Royal Army Medical Corps.
Major and Brevet Lieut.-Col. (Temp. Lieut.-Col.) FitzGerald Gabbett Fitzgerald, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) William Richard Power Goodwin, Royal Army Medical Corps.
Major William Haig, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Thomas Ernest Harty, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) William John Saundry Harvey, Royal Army Medical Corps.
Lieut.-Col. Frank Hawthorn, M.D., Royal Army Medical Corps.
Lieut.-Col. Henry Hewetson, Royal Army Medical Corps.
Lieut.-Col. Henry Charles Rupert Hime, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Andrew Edward Hodder, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Charles Walter Holden, Royal Army Medical Corps.
Capt. Frederick Duke Gwynne Howell, M.C., Royal Army Medical Corps.
Lieut.-Col. Wilfrid Edward Hudleston, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Dermot Owen Hyde, M.B., Royal Army Medical Corps.
Major Osburne Evers, M.B., Royal Army Medical Corps.
Lieut.-Col. Edgar Thomas Inkson, V.C., Royal Army Medical Corps.

Major John Tyrer Johnson, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Harry Beatty Kelly, M.B., Royal Army Medical Corps.
Lieut.-Col. James William Langstaff, Royal Army Medical Corps.
Temp. Maj. (Temp. Lieut.-Col.) Charles Edward Ligertwood, M.D., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Edmond McDonnell, M.B., Royal Army Medical Corps.
Capt. (Temp. Major) Donald Francis Mackenzie, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) James Mackinnon, Royal Army Medical Corps.
Lieut.-Col. Cecil Wilmot Mainprise, Royal Army Medical Corps.
Temp. Capt. John Dodds Marshall, M.B., Royal Army Medical Corps.
Major John St. Aubyn Maughan, Royal Army Medical Corps.
Major Cecil Roy Millar, Royal Army Medical Corps.
Temp. Capt. Robert Molyneux Miller, Royal Army Medical Corps.
Lieut.-Col. Edward Maudsley Morphew, Royal Army Medical Corps.
Major Santiago Luis-Pallant, Royal Army Medical Corps.
Temp. Capt. William Newton Parker, M.D., Royal Army Medical Corps.
Capt. (Temp. Major) Thomas Henry Peyton, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Charles Edward Pollock, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Charles William Profeit, M.B., Army Medical Service.
Lieut.-Col. (Temp. Col.) Harold Vernon Prynne, F.R.C.S., Royal Army Medical Corps.
Capt. (Temp. Major) William Brooke Purdon, M.C., M.B., Royal Army Medical Corps.
Major Lydmar Moline Purser, M.B., Royal Army Medical Corps.
Lieut.-Col. Wilson Ranson, F.R.C.S., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Matthew Burrow Ray, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Theodore Francis Ritchie, M.B., Royal Army Medical Corps.
Lieut.-Col. Horace Samson Roch, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Alexander Macgregor Rose, M.B., Royal Army Medical Corps.
Lieut. (Temp. Col.) Percy William George Sargent, M.B., F.R.C.S., Army Medical Service.
Temp. Capt. Ernest Scott, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Daniel David Shanahan, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) John Payzant Silver, M.B., Royal Army Medical Corps.
Major John Orlando Summerhayes, Royal Army Medical Corps.
Lieut.-Col. Albert George Thompson, M.B., Royal Army Medical Corps.
Major Charles Glendenning Thomson, Royal Army Medical Corps.
Major Lionel Victor Thurston, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Brian Watts, Royal Army Medical Corps.
Capt. (Temp. Lieut.-Col.) George Thomas Willan, Home Counties Field Ambulance, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Maurice Guy Winder, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Basil Fenton Wingate, Royal Army Medical Corps.
Major Richard Nason Woodley, Royal Army Medical Corps.
Capt. (Temp. Major) William Gordon Wright, Royal Army Medical Corps.
Temp. Capt. William Allen Young, M.B., Royal Army Medical Corps.

Australian Imperial Force.

Lieut.-Col. George Walter Barber, Australian Army Medical Corps.
Major Joseph Espie Dods, M.C., Australian Army Medical Corps.
Major Henry Kenneth Fry, Australian Army Medical Corps.
Lieut.-Col. (Temp. Col.) Charles Henry William Hardy, V.D., Australian Army Medical Corps.
Major Alexander Hammett Marks, Australian Army Medical Corps.
Lieut.-Col. John Hare Phipps, Australian Army Medical Corps.
Lieut.-Col. Thomas Gordon Ross, Australian Army Medical Corps.
Lieut.-Col. Charles Gordon Shaw, Australian Army Medical Corps.
Lieut.- Col. John Basil St. Vincent Welch, Australian Army Medical Corps.

Canadian Contingent.

Temp. Col. Arthur Evans Snell, Canadian Army Medical Corps.
Lieut. Col. William Webster, Canadian Army Medical Corps.
Lieut.-Col. Robert Percy Wright, Canadian Army Medical Corps.

New Zealand Force.

Lieut.-Col. Donald Norman Watson Murray, New Zealand Medical Corps.

South African Contingent.

Temp. Major Michael Stanislaus Power, South African Medical Corps.

AWARDED THE MILITARY CROSS.

Temp. Capt. William Ainslie, M.D., F.R.V.S., Royal Army Medical Corps.
Temp. Capt. Delvine Bell, M.B., F.R.C.S., Royal Army Medical Corps.
Temp. Capt. Francis Gordon Bell, M.D., F.R.C.S., Royal Army Medical Corps.
Temp. Capt. John Francis Bourke, Royal Army Medical Corps.
Temp. Capt. Hedley Boyers, M.B., Royal Army Medical Corps.
Capt. Robert Burgess, Royal Army Medical Corps.
Temp. Capt. George Beatty Burwell, M.B., Royal Army Medical Corps.
Capt. Francis Samuel Carson, Royal Army Medical Corps.
Capt. Colin Cassidy, M.B., Royal Army Medical Corps, employed Egyptian Army.
Temp. Capt. Alexander Bruce Cheves, M.B., Royal Army Medical Corps.
Capt. Alfred Joseph Clark, Royal Army Medical Corps (Special Reserve).
Capt. Thomas Courtenay Clarke, Royal Army Medical Corps.
Capt. Hugh Gregan Crawford, Royal Army Medical Corps (Special Reserve).
Temp. Capt. Douglas Edward Crosbie, Royal Army Medical Corps.
Capt. Arthur Gordon Cummins, M.B., Royal Army Medical Corps, employed Egyptian Army.
Temp. Capt. William Edgeworth David, M.B., Royal Army Medical Corps.
Capt. Duncan Davidson, M.B., Royal Army Medical Corps.
Capt. Daniel Dougal, Royal Army Medical Corps (Special Reserve).
Capt. Thomas Ingram Dun, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. John Leeper Dunlop, M.B., Royal Army Medical Corps.
Capt. Charles Derwent Edwards, M.D., Royal Army Medical Corps.
Temp. Capt. Evans Evans, Royal Army Medical Corps.
Temp. Qmr. and Hon. Lieut. Frederick George Evenden, Royal Army Medical Corps.
Capt. Thomas Gordon Fleming, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. Carleton Yates Ford, M.D., Royal Army Medical Corps.
Temp. Capt. Donald Thomas Fraser, M.B., Royal Army Medical Corps.
Capt. John Fraser, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. Archibald Fullerton, M.B., Royal Army Medical Corps.
Capt. William Rickards Galwey, M.B., Royal Army Medical Corps.
Capt. John Galbraith Gill, M.B., Royal Army Medical Corps.
Temp. Capt. David Hamilton Hadden, M.B.
Capt. George Harris Haines, Royal Army Medical Corps (Special Reserve).
Temp. Capt. Harold Parrish Hamilton, M.B., Royal Army Medical Corps.
Temp. Capt. George Francis Hardy, Royal Army Medical Carps.
Captain William Theodore Hare, Royal Army Medical Corps (Special Reserve).
Capt. William Clavering Hartgill, Royal Army Medical Corps (Special Reserve).
Capt. Robert Lance Impey, M.B., Royal Army Medical Corps (Special Reserve).
Capt. George Gordon Johnstone, M.B., Royal Army Medical Corps.
Capt. Thomas James Kelly, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. Maurice Baylis King, M.B., Royal Army Medical Corps.
Capt. Gerald Quin Lannane, F.R.C.S.I., Royal Army Medical Corps.
Temp. Lieut. James William Littlejohn, M.D., Royal Army Medical Corps.
Temp. Capt. Ambrose Lorne Lockwood, M.D., Royal Army Medical Corps.
Capt. William Ernest Craven Lunn, M.B., Royal Army Medical Corps.
Surg.-Capt. Evelyn John Hansler Luxmoore, Life Guards.
Temp. Capt. Eric Lofts Mackenzie, M.B., Royal Army Medical Corps.
Temp. Capt. William Macleod, Royal Army Medical Corps.
Temp. Capt. Alfred Malseed, M.B., Royal Army Medical Corps.
Temp. Capt. John Cuthbert Matthews, M.B., Royal Army Medical Corps.
Capt. (Temp. Lieut.-Col.) Godfrey Kindersley Maurice, Royal Army Medical Corps.
Temp. Capt. George Robert Denison McGeagh, Royal Army Medical Corps.
Temp. Capt. Adam Fisher Menzies, Royal Army Medical Corps.
Temp. Capt. Kenneth Earl Millan, M.B., Royal Army Medical Corps.
Temp. Capt. Francis John Morris, Royal Army Medical Corps.
Capt. Gerald Thomas Mullaly, M.B., F.R.C.S., Royal Army Medical Corps (Special Reserve).

Capt. Frederick John James Ney, Royal Army Medical Corps.
Temp. Lieut. William Linnell Partridge, Royal Army Medical Corps.
Temp. Lieut. Michael Gladstone Pettigrew, Royal Army Medical Corps.
Temp. Capt. Andrew Banks Raffle, M.D., Royal Army Medical Corps.
Temp. Capt. Arthur Richmond, M.B., Royal Army Medical Corps.
Capt. George Scott, M.D., Royal Army Medical Corps.
Capt. James Alwin Colville Scott, Royal Army Medical Corps.
Capt. Frederick Roland Studdert Shaw, M.B., (Special Reserve), Royal Army Medical Corps.
Temp. Capt. George Murray Shaw, M.B., Royal Army Medical Corps.
Capt. Herbert Douglas Smart, Royal Army Medical Corps.
Capt. William McElrea Snodgrass, M.B., Royal Army Medical Corps (Special Reserve).
Temp. Capt. Wilfred Newell Soden, M.D., Royal Army Medical Corps.
Capt. Leonard Boole Stott, M.B., Royal Army Medical Corps.
Temp. Lieut. David Campbell Suttie, M.B., Royal Army Medical Corps.
Capt. George Pritchard Taylor, M.B., Royal Army Medical Corps.
Temp. Capt. Francis Ruthven Thornton, Royal Army Medical Corps.
Temp. Capt. Brian William Wibberley, M.B., Royal Army Medical Corps.
Temp. Capt. David Llewelyn Williams, Royal Army Medical Corps.
Capt. Maurice Joseph Williamson, Royal Army Medical Corps.
Temp. Capt. Ivan Stuart Wilson, M.D., F.R.C.S., Royal Army Medical Corps.
Capt. John Hutchinson Wood, M.B., Royal Army Medical Corps.
Temp. Capt. John Miller Young, M.B., Royal Army Medical Corps.

Australian Imperial Force.

Capt. James Bentley, Army Medical Corps.
Capt. John Bright Birch, Army Medical Corps.
Capt. Arthur Edmund Colvin, Army Medical Corps.
Capt. Eric Mortley Fisher, Army Medical Corps.
Capt. John Thomas Jones, Army Medical Corps.
Capt. Charles Beverley Metcalfe, Army Medical Corps.

Canadian Contingent.

Capt. Angus Alexander Drinnan, Army Medical Corps.
Capt. Frederick William Lees, Army Medical Corps.
Capt. Robert Marsden Luton, Army Medical Corps.
Capt. James Ernest McAskill, Army Medical Corps.
Capt. William Freeman Nicholson, Army Medical Corps.
Capt. (Acting-Major) Paul Poisson, Army Medical Corps.
Capt. Walford Douglas Somerled Rorison, Army Medical Corps.

New Zealand Imperial Force.

Hon. Capt. George Sandham, Army Medical Corps.

AWARDED THE DISTINGUISHED CONDUCT MEDAL.

No. 117 Pte. T. W. Brown, Royal Army Medical Corps.
No. 69805 Pte. M. Charnock, Royal Army Medical Corps.
No. 1914 Serjt. E. Dugmore, Royal Army Medical Corps.
No. 50850 Cpl. T. F. Lyttle, Royal Army Medical Corps.
No. 57738 Cpl. G. Noakes, Royal Army Medical Corps.
No. 1129 Serjt. J. Powis, Royal Army Medical Corps.
No. 72297 Staff-Serjt. C. Sanders, Royal Army Medical Corps.
No. 39862 Serjt.-Major C. W. Tapson, Royal Army Medical Corps.
No. 11827 Serjt. W. White, Royal Army Medical Corps.

AWARDED THE MERITORIOUS SERVICE MEDAL.

No. 1891 Cpl. J. E. Aldridge, Royal Army Medical Corps.
No. 1094 Staff-Serjt. A. B. Alloway, Royal Army Medical Corps.
No. 4789 Pte. H. G. Beatton, Royal Army Medical Corps.
No. 10504 Pte. T. R. Begley, Royal Army Medical Corps.
No. 38512 Serjt.-Major L. J. Brain, Royal Army Medical Corps.
No. 13311 Pte. (Acting-Serjt.) G. Dunlop, Royal Army Medical Corps.
No. 68371 Pte. (Acting-Cpl.) W. Evans, Royal Army Medical Corps.

No. 51055 Staff-Serjt. C. Godsmark, Royal Army Medical Corps.
No. 165 Cpl. G. S. Iddison, Royal Army Medical Corps.
No. 953 Pte. (Acting-Lance-Cpl.) F. H. Ludlow, Royal Army Medical Corps.
No. 249 Pte. E. J. Meiklejohn, Royal Army Medical Corps.
No. 449 Lance-Serjt. E. Moss, Royal Army Medical Corps.
No. 12104 Qmr.-Serjt. (Acting-Serjt.-Major) J. E. Newton, Royal Army Medical Corps.
No. 1430 Serjt. W. T. Perkins, Royal Army Medical Corps.
No. 1305 Staff-Serjt. H. M. Prince, Royal Army Medical Corps.
No. 34796 Serjt.-Major W. G.R. Rouse, Royal Army Medical Corps.
No. 12504 Qmr.-Serjt. E. Shepherd, Royal Army Medical Corps.
No. 14958 Qmr.-Serjt. (Acting-Serjt.-Major) H. Soady, Royal Army Medical Corps.
No. 11896 Qmr.-Serjt. A. P. Spackman, Royal Army Medical Corps.
No. 725 Cpl. (Lance-Serjt.) W. A. Whittaker, Royal Army Medical Corps.
No. 35593 Serjt. W. T. Williams, Royal Army Medical Corps,

War Office,
January 13, 1917.

The following despatch has been received by the Secretary of State for War from General Sir Douglas Haig, G.C.B., Commanding-in-Chief of the British Armies in France.

General Headquarters,
November 13, 1916.

Sir,—I have the honour to submit a list of names of those officers, non-commissioned officers and men serving, or who have served, under my command, whose distinguished and gallant services and devotion to duty I consider deserving of special mention.

I have the honour to be, Sir,
Your obedient servant,
D. Haig, *General,*
Commander-in-Chief, The British Armies in France.

Major R. B. Black, M.B., Royal Army Medical Corps, Reserve of Officers.
Col. C. H. Burtchaell, C.M.G., M.B.
Surg.-Gen. W. G. Macpherson, C.B., C.M.G., M.B., Hon. Physician to the King.
Lieut.-Gen. Sir A. T. Sloggett, K.C.B., C.M.G., Hon. Surgeon to the King.

Army Medical Service.

Lt.-Col. (Temp. Col.) J. D. Alexander, M.B., Royal Army Medical Corps.
Col. G. H. Barefoot, C.M.G.
Col. A. W. Bewley.
Lieut.-Col. (Temp. Col.) R. J. Blackham, C.I.E., F.F.P.S., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) E. W. Bliss, Royal Army Medical Corps.
Col. (Temp. Col.) A. W. N. Bowen, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) G. W. Brazier-Creagh, C.M.G. (retired pay).
Col. E. G. Browne, C.B.
Major C. G. Browne, D.S.O., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) F. R. Buswell, Royal Army Medical Corps.
Lieut.-Col. A. Chopping, C.M.G., Royal Army Medical Corps.
Major J. M. H. Conway, F.R.C.S.I., Royal Army Medical Corps.
Col. G. Cree, C.M.G.
Temp. Capt. O. L. V. de Wesselow, M B.
Col. T. Daly.
Lieut.-Col. (Temp. Col.) E. B. Dowsett, Royal Army Medical Corps.
Major H. H. A. Emerson, M.B., Royal Army Medical Corps.
Brevet-Col. and Lieut.-Col. (Temp. Col.) H. Ensor, D.S.O., M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) P. Evans, C.M.G., M.B., Royal Army Medical Corps.
Lieut.-Col. H. B. Fawcus, C.M.G., M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) J. D. Ferguson, D.S.O.
Major C. H. Furnivall, Royal Army Medical Corps.
Col. J. J. Garrard, M.B.
Col. W. L. Gray, M.B.
Lieut.-Col. (Temp. Col.) F. J. Greig, Reserve of Officers.

Major (Temp. Lt.-Col.) T. E. Harty, R.A.M.C.
Lieut.-Col. H. C. R. Hime, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) H. A. Hinge, C.M.G., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) A. W. Hooper, C.M.G., D.S.O.
Major O. Ievers, M.B., Royal Army Medical Corps.
Col. (Temp. Surg.-Gen.) J. M. Irwin, M.B.
Capt. D. D. Logan, Royal Army Medical Corps.
Col. A. J. Luther.
Col. S. Macdonald, C.M.G., M.B.
Col. R. L. R. MacLeod, M.B.
Major C. J. Martin, M.B., Royal Army Medical Corps.
Major J. F. Martin, C.M.G., M.B., Royal Army Medical Corps.
Major J. St. A. Maughan, Royal Army Medical Corps.
Major C. R. Millar, Royal Army Medical Corps.
Col. F. J. Morgan.
Col. F. R. Newland, M.B.
Surg.-Gen. M. W. O'Keeffe, C.B., M.D.
Col. (Temp. Surg.-Gen.) W. W. Pike, C.M.G., D.S.O., F.R.C.S.I.
Col. H. I. Pocock.
Lieut.-Col. (Temp. Col.) J. Poe, D.S.O., M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) C. E. Pollock, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) C. W. Profeit, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) H. V. Prynne, F.R.C.S., Royal Army Medical Corps.
Major L. M. Purser, M.B.
Lieut-Col. H. S. Roch, Royal Army Medical Corps.
Major (Temp. Lt.-Col.) E. Ryan, D.S.O.
Col. B. H. Scott.
Temp. Capt. E. Scott, M.B., Royal Army Medical Corps.
Capt. T. H. Scott, M.C., M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) D. D. Shanahan, Royal Army Medical Corps.
Major G. F. Sheehan, Royal Army Medical Corps.
Major H. G. Sherren, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) J. P. Silver, M.B., Royal Army Medical Corps.
Col. B. M. Skinner, C.M.G., V.M.O.
Lieut.-Col. Temp. Col. E. W. Slayter, C.M.G., M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) F. A. Symons, D.S.O., M.B., R.A.M.C.
Major C. G. Thomson.
Col. J. Thomson, M.B.
Col. H. S. Thurston, C.M.G., Royal Army Medical Corps.
Major L. V. Thurston, Royal Army Medical Corps.
Col. T. du B. Whaite, M.B.
Major R. N. Woodley, Royal Army Medical Corps.
Col. R. W. Wright, M.B.

CONSULTANTS.

Lieut.-Col. (Temp. Surg.-Gen.) Sir A. A. Bowlby, Kt., K.C.M.G., K.C.V.O., F.R.C.S., 1st London General Hospital, Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Sir J. K. Fowler, K.C.V.O., M.D., F.R.C.P., 3rd London General Hospital, Royal Army Medical Corps.

Major (Temp. Col.) J. Galloway, M.D., F.R.C.P., F.R.C.S., 4th London General Hospital, Royal Army Medical Corps

Major (Temp. Col.) H. McI. W. Gray, C.B., M.B., F.R.C.S.Edin., 1st Scottish General Hospital, Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Sir W. P. Herringham, Kt., C.B., M.D., 1st London General Hospital, Royal Army Medical Corps.

Temp. Lieut.-Col. G. M. Holmes, M.D.

Capt. (Temp. Col.) H. M. Rigby, M.B., F.R.C.S., 2nd London General Hospital, Royal Army Medical Corps.

Temp. Col. P. W. G. Sargent, M.B., F.R.C.S., Royal Army Medical Corps.

Temp. Col. T. Sinclair, M.D., F.R.C.S.

Capt. (Temp. Col.) S. M. Smith, M.B., F.R.C.S., 3rd London General Hospital, Royal Army Medical Corps.

ROYAL ARMY MEDICAL CORPS.

Temp. Capt. E. C. Abraham, M.B.
Temp. Capt. C. Aldis, M.D.
Capt. H. S. A. Alexander, M.B., Special Reserve.
Temp. Capt. J. Anderson, M.B.
Lieut.-Col. M. H. Babington.
Capt. (Temp. Major, commanding Field Ambulance) D. C. Barron, M.B.
Temp. Capt. G. A. Barss, M.D.
Capt. J. H. Bayley. Special Reserve.
Capt. (Temp. Major) W. K. Beaman.
Capt. F. A. Bean, M.C., M.B., Special Reserve.
Maj. (Temp. Lieut.-Col.) W. Bennett, M.B.
Capt. K. Biggs, Special Reserve.
Temp. Capt. L. G. Bourdillon, D.S.O., M.C.
Capt. W. W. Boyce.
Capt. (Temp. Major) F. L. Bradish.
Temp. Capt. N. W. Broughton, D.S.O., M.B. (killed).
Major (Temp. Lieut.-Col.) J. H. Brunskill, M.B.
Major (Temp. Lieut.-Col.) R. A. Bryden.
Capt. C. D. M. Buckley, M.B., Special Reserve.
Capt. H. M. Calder, M.B., Royal Army Medical Corps.
Capt. W. K. Campbell, D.S.O., M.B., Special Reserve.
Temp. Capt. F. Carson, M.B.
Temp. Capt. W. D. Chambers, M.D.
Temp. Capt. R. Charles. F.R C.S.I.
Lieut.-Col. R. W. Clements, M.B.
Temp. Capt. J. A. Conway, M.D.
Major (Temp. Lieut.-Col.) R. H. L. Cordner.
Temp. Capt. J. Craig, M.B.
Temp. Capt. E. C. Cunnington.
Major (Temp. Lieut.-Col.) H. A. Davidson, M.B.
Temp. Capt. H. B. Day, M.B.
Capt. A. W. Dennis, M.B.
Major B. R. Dennis, M.B.
Capt. (Temp. Major) G. H. Dive.
Capt. C. O. Donovan, M.B.
Temp. Lieut.-Col. B. H. V. Dunbar, M.D.
Major (Temp. Lieut.-Col.) N. E. Dunkerton.
Lieut.-Col. (Temp. Col.) H. N. Dunn, M.B.
Capt. (Temp. Major) G. B. Edwards.
Lieut.-Col. O. W. A. Elsner.
Temp. Capt. H. Emerson, M.B.
Major (Temp. Lieut.-Col.) H. H. J. Fawcett.
Capt. G. D. Ferguson, M.B.
Brevet-Lieut.-Col. F. G. Fitzgerald.
Temp. Capt. M. FitzMaurice-Kelly, M.B., F.R.C.S.
Capt. F. G. Foster, M.B., Special Reserve.
Capt. W. Fotheringham, M.B., Special Reserve.
Lieut.-Col. R. S. H. Fuhr, D.S.O.
Major G. E. Gask. F.R.C.S.
Lieut.-Col. J. G. Gill.
Lieut. W. N. Gilmour, M.D.
Capt. E. C. Gimson, D.S O., M.B.
Lieut.-Col. G. H. Goddard.
Lieut.-Col. T. H. J. C. Goodwin, C.M.G., D.S.O.
Major (Temp. Lieut.-Col.) W. R. P. Goodwin.
Capt. N. F. Graham, M.B.
Temp. Capt. J. C. B. Grant, M.B., F.R.C.S.Edin.
Temp. Capt. H. E. Griffiths, F.R.C.S.Edin.
Capt. C. F. Hacker, M.B., Special Reserve.
Major (Temp. Lieut.-Col.) D. L. Harding, D.S.O., F.R.C.S.I.
Temp. Capt. G. F. Hardy.
Temp. Lieut. A. P. Hart, M.B.
Major (Temp. Lieut.-Col.) W. J. S. Harvey.

Lieut.-Col. H. Hewetson.
Temp. Capt. R. McC. Hill, D.S.O., M.B.
Capt. F. D. G. Howell, M.C.
Lieut.-Col. W. E. Hudleston.
Temp. Lieut. H. L. G. Hughes, D.S.O.
Capt. L. E. Hughes, Royal Army Medical Corps
Major (Temp. Lieut.-Col.) R. N. Hunt, M.B
Temp. Capt. A. Hunter, M.B.
Temp. Capt. D. W. Hunter, D.S.O., M.B.
Temp. Capt. J. T. Hurst, M.B.
Major (Temp. Lieut.-Col.) D. O. Hyde, M.B.
Temp. Capt. T. L. Ingram, D.S.O., M.C. (killed).
Lieut.-Col. E. T. Inkson, V.C.
Major (Temp. Lieut.-Col. A. E. S. Irvine, D.S.O.
Capt. C. Jacobs, M.B.
Capt. D. W. John, Special Reserve.
Temp. Capt. J. G. Johnston, M.B.
Temp. Lieut. D. S. Jones.
Capt. E. J. Kavanagh, M.C., M.B.
Temp. Capt. A. C. Keay, M.B.
Major (Temp. Lieut.-Col.) H. B. Kelly, M.B.
Capt. A. J. Kendrew, M.C., M.B.
Major (Temp. Lieut.-Col.) E. B. Knox, M.D.
Capt. H. D. Lane, Royal Army Medical Corps.
Lieut.-Col. J. W. Langstaff.
Capt. J. Lawson, M.B., Special Reserve.
Temp. Major (Temp. Lieut.-Col.) C. E. Ligertwood, M.D.
Temp. Lieut. E. M. Litchfield.
Capt. D. Macfadyen, M.B., Special Reserve.
Temp. Lieut. N. McFarlane, M.B. (since relinquished his commission).
Temp. Capt. H. R. Macintyre, M.D.
Capt. (Temp. Major) D. F. Mackenzie, M.B.
Temp. Capt. J. T. MacKenzie (since relinquished his commission).
Temp. Major R. Magill, M.B.
Lieut.-Col. C. W. Mainprise.
Capt. A. G. Maitland-Jones.
Capt. J. D. Marshall, M.B.
Temp. Capt. A. F. Mavety, M.B.
Major S. M. W. Meadows.
Temp. Capt. R. W. Michell, M.D., F.R.C.S.
Capt. R. M. Miller.
Capt. T. M. Miller, M.C., Special Reserve.
Capt. W. A. Miller, D.S.O., M.B., Special Reserve.
Major (Temp. Lieut.-Col.) E. H. M. Moore.
Capt. H. Moore.
Major T. B. Moriarty.
Lieut.-Col. E. M. Morphew.
Capt. C. R. M. Morris, M.B.
Capt. H. G. Mulholland, M.B.
Temp. Capt. W. G. Mumford, M.B., F.R.C.S.
Capt. (Temp. Major) K. D. Murchison, M.B.
Capt. T. P. Noble, M.D.
Lieut.-Col. H. H. Norman, M.B.
Major (Temp. Lieut.-Col.) A. C. Osburn, D.S.O.
Temp. Capt. W. N. Parker, M.D.
Temp. Capt. W. H. Parry, M.B.
Capt. E. Percival, D.S.O., M.B.
Capt. A. Picken, M.B.
Temp. Lieut. J. A. Pierse, M.B.
Temp. Lieut. S. Potter.
Major T. J. Potter.
Capt. (Temp. Major) W. B. Purdon, M.C., M.B.
Capt. J. P. Quinn, M.B., Special Reserve.
Capt. J. Rafter, M.B.

Temp. Capt. A. F. Readdie.
Capt. D. O. Riddel.
Major (Temp. Lieut. Col.) T. F. Ritchie, M.B
Temp. Capt. G. D. Robertson.
Temp. Capt. H. H. Robinson, D.S.O.
Capt. (Temp. Major) T. T. H. Robinson, M.B.
Major (Temp. Lieut.-Col.) A. M. Rose, M.B.
Temp. Capt. T. A. Rothwell, M.D.
Temp. Lieut. L. M. Rowlette.
Temp. Capt. G. W. R. Rudkin.
Major (Temp. Lieut.-Col.) A. W. F. Sayres.
Capt. R. L. Scott, M.B., F.R.C.S.Edin.
Capt. R. S. Scott.
Temp. Capt. E. Seelly, M.B.
Capt. E. J. Selby.
Surg.-Major A. W. Shea.
Capt. B. C. O. Sheridan, M.B.
Capt. A. A. Smalley, M.B., Special Reserve.
Major (Temp. Lieut.-Col.) H. G. Smeeth, M.D.
Capt. J. Stephenson.
Major (Temp. Lieut.-Col.) H. Stewart, M.C., M.B.
Capt. G. V. Stockdale, M.B., Special Reserve.
Lieut. R. Svensson, M.B.
Capt. L. W. O. Taylor, Special Reserve.
Temp. Capt. J. C. T. Teggart.
Temp. Capt. L. H. Terry.
Lieut.-Col. A. G. Thompson, M.B.
Major (Temp. Lieut.-Col.) R. J. C. Thompson, D.S.O.
Major (Temp. Lieut.-Col.) P. Turner, M.D.
Capt. D. C. Vey.
Temp. Major (Temp. Lieut.-Col.) A. N. Walker, M.B., Royal Army Medical Corps (killed).
Temp. Capt. H. Walker.
Lieut. M. J. T. Wallis.
Capt. J. R. N. Warburton, Special Reserve.
Temp. Capt. P. L. Watkin-Williams, D.S.O., F.R.C.S.
Lieut.-Col. A. A. Watson, M.B., Special Reserve.
Lieut.-Col. (Temp. Col.) B. Watts.
Capt. J. B. A. Wigmore, M.B.
Major W. Wiley, M.B.
Major R. C. Wilmot.
Capt. G. R. C. Wilson.
Temp. Capt. H. B. Wilson, M.D.
Major (Temp. Lieut.-Col.) M. G. Winder.
Major (Temp. Lieut.-Col.) B. F. Wingate.
Capt. (Temp. Major) W. G. Wright.
Temp. Captain G. D. Yates, M.B.
Capt. W. H. Young.
Qmr. and Hon. Capt. E. T. Buckley.
Qmr. and Hon. Major J. B. Short.
Qmr. and Hon. Lieut. S. C. R. Chester.
Qmr. and Hon. Lieut. F. E. Collard.
Qmr. and Hon. Lieut. J. M. Maxwell.
Temp. Qmr. and Hon. Lieut. C. A. Kay.
No. 45811 Cpl. R. Ashley.
No. 48754 Cpl. (Acting-Serjt.) E. Barmby.
No. 37307 Serjt. J. Barnett.
No. 68269 Pte. F. Barron.
No. 36490 Serjt.-Major D. J. D. Belford.
No. 17 Serjt. A. C. Berry.
No. 7249 Cpl. H. L. G. Buckingham.
No. 2120 Cpl. (Acting Qmr.-Serjt.) W. M. Burnett.
No. 40169 Pte. E. L. Cartwright.
No. 17501 Staff-Serjt. J. Christie.

No. 45734 Regtl. Serjt.-Major J. P. Clayton.
No. 30511 Serjt.-Major A. J. Coggins.
No. 11929 Staff-Serjt. W. J. Cooper.
No. 12352 Serjt.-Major J. H. Curtis.
No. 51398 Staff-Serjt. D. J. Davies.
No. 11626 Serjt.-Major H. J. Easey.
No. 18678 Qmr.-Serjt. L. S. Ellis.
No. 67264 Pte. (Acting-Lance-Cpl.) H. Ellison.
No. 65867 Pte. H. Everall.
No. 65692 Cpl. (Acting-Lance-Serjt.) F. Fowler.
No. 40655 Serjt.-Major H. J. C. Frewin.
No. 44572 Qmr.-Serjt. R. G. Griggs.
No. 65457 Cpl. B. W. Gunn.
No. 2046 Staff-Serjt. F. J. Hammond.
No. 4357 Serjt. T. H. Harding.
No. 34124 Serjt.-Major A. P. Hatt.
No. 31891 Staff-Serjt. W. Hughes.
No. 17229 Serjt.-Major W. Hutchens.
No. 30623 Serjt.-Major J. R. Ivins.
No. 30534 Pte. (Acting-Serjt.) R. H. King.
No. 54095 Serjt.-Major G. B. Lee.
No. 36229 Serjt.-Major J. McDowall.
No. 13399 Pte. (Acting-Cpl.) T. Nelson.
No. 30569 Serjt.-Major J. Newton.
No. 20007 Serjt. G. Oliver.
No. 17714 Staff-Serjt. A. R. Robinson.
No. 12623 Serjt.-Major H. S. Rolfe.
No. 56269 Cpl. G. A. Sage.
No. 563 Pte. C. H. Stevens.
No. 42976 Cpl. (Acting-Serjt.) W. H. Stewart.
No. 53424 Cpl. (Acting-Serjt.) A. Todd.
No. 17928 Qmr.-Serjt. W. S. Toye.
No. 45681 Staff-Serjt. A. V. Waters.
No. 11320 Serjt.-Major R. Watts.
No. 57449 Cpl. W. Wills.
No. 12146 Serjt.-Major W. J. Wilson.
No. 5442 Serjt. A. E. Woodward.
Capt. F. R. Armitage, M.B.
Major W. B. Armstrong, M.B.
Temp. Lieut.-Col. W. A. Benson.
Major (Temp. Lieut.-Col.) E. B. Bird.
Capt. (Temp. Major) C. S. Brebner, M.D.
Captain W. D. Carruthers, M.B.
Capt. H. M. Clarke, M.B.
Capt. J. Clayton.
Lieut.-Col. W. K. Clayton.
Capt. S. J. Clegg, M.B.
Lieut.-Col. W. B. Cockill, M.D., T.D.
Lieut.-Col. H. Collinson, M.B., F.R.C.S.
Temp. Capt. M. Coplans, M.D.
Capt. W. H. Davison, M.B.
Major (Temp. Lieut.-Col.) L. P. Demetriadi, M.D., F.R.C.S.
Capt. M. Dixon, M.D.
Capt. F. Ellis.
Capt. N. M. Fergusson, M.B.
Capt. P. A. Galpin, M.D.
Capt. (Temp. Major) T. A. Green, M.D.
Capt. D. A. R. Haddon, M.B.
Major W. Haig, M.B.
Lieut.-Col. F. Hawthorn, M.D.
Major (Temp. Lieut.-Col.) A. E. Hodder, M.B.
Capt. H. Lightstone, M.C.
Capt. C. H. Lilley, M.B.
Capt. H. A. Lucas.

Capt. (Temp. Major) G. Mackie.
Major (Temp. Lieut.-Col.) J. Mackinnon.
Major M. J. Mahoney, D.S.O., M.D., T.D.
Capt. J. S. Manford, M.B.
Capt. J. E. Milne, D.S.O., M.D.
Major (Temp. Lieut.-Col.) E. C. Montgomery-Smith.
Capt. E. B. Pike.
Lieut.-Col. W. Ranson, F.R.C.S.Edin.
Major (Temp. Lieut. Col.) M. B. Ray, M.D.
Capt. W. L. Robertson, M.B., F.R.C.S.Edin.
Capt. G. Scott, M.B.
Lieut.-Col. (Temp. Col.) A. D. Sharp, F.R.C.S., C.M.G.
Capt. G. C. E. Simpson, M.B., F.R.C.S.
Capt. C. N. Smith, M.B.
Capt. G. F. R. Smith, M.B.
Major J. O. Summerhayes.
Temp. Lieut. W. J. E. Stuttaford.
Capt. J. H. Thomas.
Capt. J. E. G. Thompson.
Temp. Capt. J. Upcott, F.R.C.S.
Capt. A. Wilson, M.B.
Major (Temp. Lieut.-Col.) J. Wood.
Qmr. and Hon. Lieut. R. D. Matthews.
Qmr. and Hon. Lieut. W. H. Russell.
Qmr. and Hon. Lieut. D. P. Taylor.
No. 2373 Serjt. H. C. Blench.
No. 1697 Serjt. (Acting Staff-Serjt.) W. Brooke.
No. 83 Serjt. G. K. Burnett.
No. 1239 Staff-Serjt. (Acting Serjt.-Major) J. Creese.
No. 2236 Staff-Serjt. F. W. Delacour.
No. 224 Staff-Serjt. (Acting Serjt.-Major) R. Duncan.
No. 1604 Pte. A. L. Fraser.
No. 1569 Lance-Cpl. S. F. Goodman.
No. 2517 Pte. T. E. Hill.
No. 9 Cpl. (Acting Staff-Serjt.) G. H. W. Hunter.
No. 1720 Pte. L. Judd.
No. 2056 Lance-Cpl. (Acting Serjt.) S. McClure.
No. 61 Qmr.-Serjt. T. H. Potter.
No. 1257 Serjt. A. Robson.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

January 4, 1917.

His Majesty has been graciously pleased to sanction the following promotions in, and appointments to, the Order of the Hospital of St. John of Jerusalem in England.

As Knights of Grace.

Col. Sir John Rose Bradford, K.C.M.G., C.B., M.D., F.R.C.S., Army Medical Service.
Col. Alfred Percy Blenkinsop, C.B., M.R.C.S., Army Medical Service.
Col. Sinclair Westcott, C.B., C.M.G., L.R.C.P.Ed., Army Medical Service.
Surg.-Gen. John Chislet Culling, M.R.C.S., Army Medical Service.

As Esquires.

Lieut.-Col. William Blackwell, L.R.C.S.I., Royal Army Medical Corps.

War Office,
January 6, 1917.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned non-commissioned officers and men :—
No. 41501 Pte. J. H. Archer, Royal Army Medical Corps.
No. 14774 Pte. D. Armour, Royal Army Medical Corps.
No. 1832 Pte. C. M. Balson, Royal Army Medical Corps.
No. 1542 Lance-Serjt. S. H. Bassadona, Royal Army Medical Corps.

No. 69314 Pte. F. Bradley, Royal Army Medical Corps.
No. 63805 Pte. H. Brooker, Royal Army Medical Corps.
No. 66075 Cpl. (Acting Serjt.) T. E. Brown, Royal Army Medical Corps.
No. 30575 Serjt. M. Colhoun, Royal Army Medical Corps.
No. 74743 Pte. L. Cutler, Royal Army Medical Corps.
No. 5311 Pte. G. Fitzharris, Royal Army Medical Corps.
No. 7551 Pte. W. Fox, Royal Army Medical Corps.
No. 38657 Serjt. L. Gillies, Royal Army Medical Corps.
No. 67333 Acting Serjt. H. E. Goodacre, Royal Army Medical Corps.
No. 66539 Pte. C. Gould, Royal Army Medical Corps.
No. 64650 Pte. W. Guthrie, Royal Army Medical Corps.
No. 39505 Pte. N. M. Hall, Royal Army Medical Corps.
No. 2002 Pte. T. Halton, Royal Army Medical Corps.
No. 67052 Serjt. R. Holt, Royal Army Medical Corps.
No. 1666 Pte. J. Houghton, Royal Army Medical Corps.
No. 20424 Pte. W. Kinley, Royal Army Medical Corps.
No. 334 Pte. T. Lundie, Royal Army Medical Corps.
No. 74923 Pte. C. S. Moore, Royal Army Medical Corps.
No. 1238 Pte. M. Moss, Royal Army Medical Corps.
No. 6-242 Pte. E. W. Munden, Royal Army Medical Corps.
No. 52775 Serjt. H. G. T. Munson, Royal Army Medical Corps.
No. 66844 Serjt. W. H. Palmer, Royal Army Medical Corps.
No. 45476 Pte. J. Paterson, Royal Army Medical Corps.
No. 67429 Acting Cpl. P. Pinder, Royal Army Medical Corps.
No. 46135 Pte. J. Quinn, Royal Army Medical Corps.
No. 74787 Pte. (Acting Lance-Cpl.) E. J. Richardson, Royal Army Medical Corps.
No. 66682 Pte. L. T. Robbins, Royal Army Medical Corps.
No. 1689 Cpl. (Acting Serjt.) H. Shields, Royal Army Medical Corps.
No. 74412 Pte. A. Stevens, Royal Army Medical Corps.
No. 42265 Pte. W. Sutcliffe, Royal Army Medical Corps.
No. 1819 Cpl. A. G. Upton, Royal Army Medical Corps.
No. 2014 Lance Cpl. H. Watson, Royal Army Medical Corps.
No. 67027 Serjt. T. F. Wilson, Royal Army Medical Corps.

The undermentioned has been awarded a Bar to his Military Medal :—
No. 1663 Cpl. C. Hamilton, Royal Army Medical Corps.
(The awards of the Military Medal above-mentioned were published in the *London Gazette* dated November 16, 1916.)

October 27, 1916.

For No. 1329 Cpl. J. Malia, Royal Army Medical Corps, *read* No. 1329 Cpl. J. Malia, Royal Army Medical Corps, Territorial Force.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned officers in recognition of their gallantry and devotion to duty in the field :—

Capt. Edward James Blair, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under heavy fire continuously for eighteen hours. He set a splendid example of courage and determination throughout.

Capt. Hawtrey William Brown, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He made a tour of five regimental aid posts under very heavy fire, and carried in many wounded men. He set a splendid example throughout.

Temp. Capt. William George Thomas Hepplewhite, M.D., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He worked unceasingly day and night supervising his bearers, clearing the wounded under very heavy fire. He set a splendid example throughout.

Temp. Capt. Herbert Bruce Low, M.D., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He dressed the wounded and supervised the work of the bearers under very heavy fire. He set a splendid example of courage and coolness throughout.

Capt. John Wright Malcolm, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination in constantly directing bearer squads under heavy fire. On another occasion he rescued several men who were buried.

Temp. Capt. Victor Harold Mason, M.B., Royal Army Medical Corps, East Yorkshire Regiment.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending and dressing the wounded under very heavy fire.

Temp. Capt. Lloyd Remington Meech, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He worked continuously for forty-eight hours collecting wounded under very heavy fire. He set a splendid example throughout.

Temp. Lieut. Alexander Gordon Peter, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He tended and dressed the wounded under very heavy fire, displaying great courage and determination throughout.

Temp. Lieut. Albert Edward Sutton, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending the wounded under heavy fire. He worked single-handed all night in an advanced post.

Temp. Capt. Harold Ernest Pierpoint Yorke, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending the wounded under very heavy fire. Later, although himself wounded, he continued to carry out his work.

Canadian Force.

Capt. William Malloch Hart, Canadian Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and skill in evacuating wounded under most trying conditions. On one occasion he worked for several hours in the open under heavy fire attending to the wounded. He has previously done fine work.

Amendments.

The following corrections are made in the *London Gazette* announcements:—

November 14, 1916.

For Temp. Capt. Richard Harold Hodges, Royal Army Medical Corps, *read* Capt. Richard Harold Hodges, Royal Army Medical Corps, Special Reserve.

January 1, 1917.

Page 31, *delete* Capt. Robert Burgess, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-commissioned Officer for acts of gallantry and devotion to duty in the field:—

31476 Staff Sergt. W. A. Potter, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He organized a party and brought in two wounded men. On another occasion he went out from the advanced dressing-station under heavy fire and brought in five wounded men. He set a splendid example throughout.

LIST No. 246.

General Headquarters,
January 15, 1917.

Honours and Rewards.

Under authority granted by His Majesty the King to the Commander-in-Chief, Egyptian Expeditionary Force, the following honours have been awarded to the undermentioned Warrant Officers and Non-commissioned Officers, for meritorious service in the Field:—

Meritorious Service Medal.

No. 12676 Staff-Serjt. (Acting-Staff-Serjt.-Major) E. A. Young, Royal Army Medical Corps.

No. 11059 Qmr.-Serjt. James Dunn, Royal Army Medical Corps.

(*Signed*) S. H. Pollen,
Lieutenant-Colonel,
Assistant Military Secretary, E.E.F.

War Office,
January 22, 1917.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned Non-commissioned Officers and Men :—

No. 1587 Pte. W. Abba, Royal Army Medical Corps.
No. 65924 Pte. J. Abraham, Royal Army Medical Corps.
No. 32276 Pte. (Acting.Serjt.) T. Boyd, Royal Army Medical Corps.
No. 1665 Pte. R. Carling, Royal Army Medical Corps.
No. 1523 Serjt. J. W. Cherry, Royal Army Medical Corps.
No. 72015 Pte. F. W. Clipsom, Royal Army Medical Corps.
No. 46228 Serjt. F. C. Cornish, Royal Army Medical Corps.
No. 49334 Pte. G. Crouch, Royal Army Medical Corps.
No. 63808 Pte. R. Dugdale, attached Royal Army Medical Corps.
No. 1558 Pte. P. Elton, Royal Army Medical Corps.
No. 42441 Pte. G. A. Groves, Royal Army Medical Corps.
No. 2051 Pte. J. Hackett, Royal Army Medical Corps.
No. 1911 Pte. J. S. S. Hay, Royal Army Medical Corps.
No. 55621 Pte. T. H. Hobson, Royal Army Medical Corps.
No. 41 Pte. A. E. Holmes, Royal Army Medical Corps.
No. 42357 Pte. C. Kennedy, Royal Army Medical Corps.
No. 82054 Pte. B. King, Royal Army Medical Corps.
No 1565 Pte. L. A. Learmouth, Royal Army Medical Corps.
No. 38887 Pte. J. Miller, Royal Army Medical Corps.
No. 65772 Pte. H. C. Neale, Royal Army Medical Corps.
No. 867 Serjt. R. Norrie, Royal Army Medical Corps.
No. 64337 Serjt. J. H. Nutter, Royal Army Medical Corps.
No. 1965 Cpl. H. Pallister, Royal Army Medical Corps.
No. 49496 Pte. W. Paterson, Royal Army Medical Corps.
No. 2076 Serjt. R. S. Pearce, Royal Army Medical Corps.
No. 1310 Pte. W. Pearson, Royal Army Medical Corps.
No. 9663 Pte. J. E. Player, Royal Army Medical Corps.
No. 72068 Pte. A. Powell, Royal Army Medical Corps.
No. 65792 Serjt. A. G. Reeve, Royal Army Medical Corps.
No. 72102 Pte. H. A. Runham, Royal Army Medical Corps.
No. 40 Cpl. N. Russell, Royal Army Medical Corps.
No. 33983 Pte. R. R. Smith, Royal Army Medical Corps.
No. 243 Staff-Serjt. A. Sparkes, Royal Army Medical Corps.
No. 65880 Pte. E. J. Stevens, Royal Army Medical Corps.
No. 1436 Pte. C. Tawse, Royal Army Medical Corps.
No. 68652 Pte. J. Titterington, Royal Army Medical Corps.
No. 34883 Pte. D. Todd, Royal Army Medical Corps.
No. 60866 Pte. W. E. Treadwell, Royal Army Medical Corps.
No. 214 Serjt. W. T. Vickery, Royal Army Medical Corps.
No. 72040 Pte. A. L. Webb, Royal Army Medical Corps.
No. 1932 Serjt. W. L. Whittaker, Royal Army Medical Corps.
No. 1034 Lance-Serjt. A. Wilson, Royal Army Medical Corps.

The undermentioned have been awarded a Bar to their Military Medal :—

No. 53148 Pte. (Acting-Cpl.) E. Broomhall, Royal Army Medical Corps.
No. 49581 Pte. J. Golden, Royal Army Medical Corps.

(The awards of the Military Medals above-mentioned were published in the *London Gazette*, dated October 21, 1916.)

November 9, 1916.

For No. 20013 Lance-Cpl. A. Avery, Royal Army Medical Corps, *read* No. 20706 Lance-Cpl. A. Avery, Royal Army Medical Corps.

December 9, 1916.

For No. 54578 R. W. Henderson, Royal Army Medical Corps, *read* No. 54578 Pte. R. W. Henderson, Royal Army Medical Corps.

For No. 42084 Pte. C. L. Hughes, Royal Army Medical Corps, *read* No. 42084 Pte. L. C. Hughes, Royal Army Medical Corps.

Central Chancery of the Orders of Knighthood.

Lord Chamberlain's Office,
St. James's Palace, S.W.
January 24, 1917.

The King has been graciously pleased to give orders for the following promotions in, and appointments to, the Most Honourable Order of the Bath, for services rendered in connection with the war. The promotions and appointments to date from the 1st inst.:—

To be Additional Member of the Military Division, of the First Class, or Knight Grand Cross of the said Most Honourable Order:—

Surg.-Gen. Sir Alfred Keogh, K.C.B., M.D., F.R.C.P. (retired pay).

To be Additional Member of the Military Division of the Second Class, or Knight Commander, of the said Most Honourable Order:—

Surg.-Gen William Donovan, C.B. (retired pay).

Australian Imperial Force.

Col. (Temp. Surg.-Gen.) Neville Reginald Howse, V.C., C.B., Australian Army Medical Corps.

To be Additional Members of the Military Division of the Third Class, or Companions, of the said Most Honourable Order:—

Surg.-Gen. William Wallace Kenny, M.B., F.R.C.S.I. (retired pay).

Col. Edward North, F.R.C.S. (retired pay), Army Medical Service.

Col. William Heaton Horrocks, M.B., Army Medical Service.

Col. Donald James MacKintosh, M.V.O., M.B., Army Medical Service (Territorial Force Reserve).

Col. Charles Cooper Reilly, Army Medical Service.

Col. James Thomson, M.B., Army Medical Service.

Surg. Lieut.-Col. Peter Johnson Freyer, M.D. (retired), Indian Medical Service.

Lieut.-Col. Thomas Horrocks Oppenshaw, C.M.G., M.B., F.R.C.S., Royal Army Medical Corps (Territorial Force).

Lieut.-Col. Harry Gilbert Barling, F.R.C.S., Royal Army Medical Corps (Territorial Force).

Lieut.-Col. Henry Davy M.D., Royal Army Medical Corps (Territorial Force).

Temp. Lieut.-Col. Sir Thomas Myles, M.D., F.R.C.S.I., Royal Army Medical Corps.

Temp. Lieut.-Col. Sir William Arbuthnot Lane, Bt., M.B., F.R.C.S., Royal Army Medical Corps.

Temp. Lieut.-Col. James Swain, M.D., F.R.C.S., Royal Army Medical Corps.

Temp, Lieut.-Col. William Aldren Turner, M.D., Royal Army Medical Corps.

Temp. Lt.-Col. Sir Berkeley George Andrew Moynihan, M.B., F.R.C.S., Royal Army Medical Corps.

Temp. Lieut.-Col. (Temp. Col.) Robert Jones, F.R.C.S., Royal Army Medical Corps.

Chancery of the Order of St. Michael and St. George.

Downing Street,
January 24, 1917.

The King has been graciously pleased to give directions for the following promotion in, and appointments to, the Most Distinguished Order of St. Michael and St. George, in recognition of valuable services in connection with the war. To be dated January 1, 1917:—

To be Additional Member of the Second Class, or Knight Commander, of the said Most Distinguished Order:—

Surg.-Gen. George Dean Bourke, C.B. (retired pay).

To be additional Members of the Third Class, or Companions, of the said Most Distinguished Order:—

Lieut.-Col. William Wippell Pope, late Royal Army Medical Corps.

Lieut.-Col. George Edward Twiss, F.R.C.S.I. (retired pay), late Royal Army Medical Corps.

Lieut.-Col. Harry Edwin Bruce Bruce-Porter, Royal Army Medical Corps.

Lieut.-Col. George Bradshaw Stanistreet, M.B., Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Robert Strickland Hannay Fuhr, D.S.O., Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Harold Percy Walter Barrow, Royal Army Medical Corps.

Temp. Hon. Lieut.-Col. John Lynn Thomas, C.B., F.R.C.S., Royal Army Medical Corps (Major, retired, Territorial Force).

Major George Lovell Gulland, M.D., F.R.C.P., Royal Army Medical Corps.

New Zealand Force.

Col. Hon. William Edward Collins, M.B., M.R.C.S. New Zealand Medical Corps.

War Office,
January 24, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned Honours and Rewards for valuable services rendered in connexion with the War, with effect from January 1, 1917, inclusive, except where otherwise stated:—

To be Brevet-Colonels.

Lieut.-Col. H. A. Haines, M.D., Royal Army Medical Corps.
Lieut.-Col. C. J. Jacomb-Hood, 2nd Eastern General Hospital, Royal Army Medical Corps, T.F. Reserve.

To be Brevet-Colonel on the Retired List.

Lieut.-Col. A. W. Browne, retired pay; late Royal Army Medical Corps.

To be Brevet-Lieutenant-Colonels.

Major (Temp. Lieut.-Col.) B. A. Craig, Royal Army Medical Corps.
Major F. McLennan, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) A. H. Safford, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) C. R. Sylvester Bradley, Royal Army Medical Corps, commanding Training Centre.

To be Brevet-Majors.

Capt. A. E. G. Fraser, Royal Army Medical Corps.
Capt. (Temp. Major) R. W. D. Leslie, Royal Army Medical Corps.

Awarded the Military Cross.

Capt. Herbert Vernon Stanley, M.B., Royal Army Medical Corps.

Awarded the Distinguished Conduct Medal.

No. 76050 Pte. A. A. Devey, Royal Army Medical Corps.

War Office,
January 25, 1917.

The names of the undermentioned have been brought to the notice of the Secretary of State for War for distinguished services rendered in connexion with the War:—

Temp. Lieut.-Col. Sir W. A. Arbuthnot Lane, Bart., M.B., F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. H. G. Barling, F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. H. P. W. Barrow, Royal Army Medical Corps.
Surg.-Gen. G. D. Bourke, C.B.
Lieut.-Col. A. W. Browne, Royal Army Medical Corps (retired).
Lieut.-Col. H. E. B. Bruce-Porter, Royal Army Medical Corps.
Col. Hon. W. E. Collins, M.B., M.R.C.S., New Zealand Medical Corps.
Lieut.-Col H. Davy, M.D., Royal Army Medical Corps.
Major W. I. de Courcy Wheeler, Royal Army Medical Corps.
Surg. Lieut.-Col. P. J. Freyer, M.D., Indian Medical Service (retired).
Capt. P. J. Gaffikin, Royal Army Medical Corps.
Lieut.-Col. G. M. Goldsmith, Royal Army Medical Corps.
Major G. L. Gulland, M.D., Royal Army Medical Corps.
Lieut -Col. H. A. Haines, M.D., Royal Army Medical Corps.
Col. W. H. Horrocks, M.B., Army Medical Service.
Lieut.-Col. C. J. Jacomb-Hood, Royal Army Medical Corps.
Temp. Col. R. Jones, F.R.C.S., Royal Army Medical Corps.
Surg.-Gen. W. W. Kenny, M.B., F.R.C.S.I., late Royal Army Medical Corps.
Col. D. J. MacKintosh, M.V.O., M.B.
Lieut.-Col. W. J. Macnamara, Royal Army Medical Corps.
Temp. Lieut.-Col. Sir T. Myles, Knt., M.D., F.R.C.S.I., Royal Army Medical Corps.
Col. E. North, F.R.C.S.Edin., late Royal Army Medical Corps.
Lieut.-Col. T. H. Openshaw, C.M.G., M.B., F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. W. W. Pope, late Royal Army Medical Corps.
Capt. W. A. Robertson, Royal Army Medical Corps.

Col. S. C. B. Robinson.
Lieut.-Col. G. B. Stanistreet, M.B., Royal Army Medical Corps.
Temp. Lieut.-Col J. Swain, M.D., F.R.C.S., Royal Army Medical Corps.
Temp. Lieut.-Col. Hon. J. L. Thomas, C.B., F.R.C.S., Royal Army Medical Corps (Major retired T.F.).
Lieut.-Col. T. B. A. Tuckey, Royal Army Medical Corps.
Temp. Lieut.-Col. W. A. Turner, M.D., Royal Army Medical Corps.
Lieut.-Col. G. E. Twiss, F.R.C.S.I., retired pay, late Royal Army Medical Corps.
No. 76707 Pte. (Acting Serjt.) G. H. Goodfellow, Royal Army Medical Corps.
No. 2065 Pte. M. Gosse, Royal Army Medical Corps.
No. 26546 Cpl. D. J. Stewart, Royal Army Medical Corps.
No. 76162 Pte. (Acting Cpl.) H. E. White, Royal Army Medical Corps.

War Office.
January 26, 1917.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned officer to be Companion of the Distinguished Service Order, in recognition of his gallantry and devotion to duty in the field :—

Temp. Capt. Dyfrig Huws Pennant, Royal Army Medical Corps, attached headquarters Royal Field Artillery.
For conspicuous gallantry and devotion to duty. He dressed and remained with three wounded men under the most intense fire. He has at all times set a splendid example of courage and coolness, and has on many occasions done fine work.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers and Warrant Officers, in recognition of their gallantry and devotion to duty in the field :—

Lieut. Daniel Davies Evans, Royal Army Medical Corps., Special Reserve, attached Royal Dublin Fusiliers.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination in collecting and attending to the wounded under very heavy fire.

Temp. Capt. Rupert Farrant, F.R.C.S., Royal Army Medical Corps, attached Shropshire Light Infantry.
For conspicuous gallantry and devotion to duty. During the whole day he tended wounded in an open trench which was subjected to a violent bombardment. On one occasion he led a party into "No Man's Land" and brought in several wounded men.

Temp. Capt. Frank Anthony Hampton, M.B., Royal Army Medical Corps, attached Royal Scots.
For conspicuous gallantry and devotion to duty. He continually went out under very heavy fire and remained in the open attending to the wounded with the utmost bravery and coolness. He has previously done fine work.

Temp. Capt. John Samuel Levis, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination when in charge of stretcher-bearers under heavy fire. He has on many previous occasions done fine work.

Temp. Capt. Francis Cromby Macaulay, M.B., Royal Army Medical Corps.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination in collecting and attending to the wounded under very heavy fire.

Temp. Capt. Philip Hugh Rawson, Royal Army Medical Corps, attached South Staffordshire Regiment.
For conspicuous gallantry in action. On several occasions he rescued wounded men under very heavy fire. He set a fine example of courage and coolness throughout.

Capt. Arthur Ashton Smalley, M.B., Royal Army Medical Corps, Special Reserve.
For conspicuous gallantry and devotion to duty. He displayed great courage and determination in attending to the wounded, working continuously for forty-eight hours under heavy fire. He set a fine example throughout.

AUSTRALIAN IMPERIAL FORCE.

Capt. Wilmot Fenwick, Australian Medical Corps.
For conspicuous gallantry and devotion to duty. He worked continuously for forty-eight hours under very heavy fire tending and dressing the wounded. He set a splendid example of coolness and courage throughout.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Non-Commissioned Officer for acts of gallantry and devotion to duty in the field :—

2100 Serjt. E. B. Trotter, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination when in charge of a number of stretcher-bearer squads. On several occasions he personally tended the wounded under very heavy fire.

AMENDMENT.

The following correction is made in *London Gazette* announcements :—

January 1, 1917.

Page 38.—The award of the Military Cross to Temp. Capt. Francis John Morris, Royal Army Medical Corps, is cancelled, and the following substituted : Capt. John Morris, M.B., F.R.C.S., Royal Army Medical Corps, Territorial Force, attached Cheshire Regiment.

FIFTH ARMY MEDICAL SOCIETY.

A LARGELY attended meeting of Medical Officers of the Fifth Army in the Field, was held at No. 4, C.C.S., on December 2, 1916. Surgeon-General Bruce Skinner occupied the Chair, and, after a few introductory remarks explaining the object and scope of the proposed Society, he placed a motion for its formation before the meeting. This was agreed to unanimously.

A paper was then read by Captain Walters of the Special Abdominal Hospital upon "Abdominal Injuries: their diagnosis and pre-operative treatment." A discussion followed in which Colonel Maynard Smith, Consulting Surgeon, Fifth Army, Captain Hughes, Captain Bolas, and others took part.

Colonel Percy Evans then read some notes upon a severe but localized outbreak of enteric fever in a village in the Army area. The outbreak was confined to the civil population of the village and the infection of each individual case was traceable to the same house.

Surgeon-General Skinner then proposed a vote of thanks to Captain Walters, Colonel Evans, and those who had discussed the papers, after which the proceedings terminated.

J. M. RAHILLY, *Lieut.-Col., R.A.M.C.*
J. J. M. SHAW, *Capt., R.A.M.C.*
Joint Hon. Secretaries.

THE ROYAL SOCIETY OF MEDICINE AND THE NAVAL AND MILITARY MEDICAL SERVICES.

THE Council of this Society extends a cordial invitation to the Commissioned Officers of the Naval and Military Medical Services, when in London, to make free use of the Society's Rooms (which include Writing, Smoking, Tea, Conference and Dressing Rooms), and to use the Library for purposes of reading and reference.

They are further welcome to attend any of the numerous meetings which are held for papers and discussions, which are announced in the medical journals each week. The Society's House (1, Wimpole Street, Cavendish Square, W.), is open from 11 to 6.30.

ROYAL ARMY MEDICAL CORPS FUND.

PROCEEDINGS OF A COMMITTEE MEETING HELD AT THE WAR OFFICE ON THURSDAY, JANUARY 18, 1917, IN ROOM 356.

Present:

Surgeon-General M. W. Russell, C.B., in the Chair.
Surgeon-General Sir David Bruce, C.B., F.R.S.
Colonel E. M. Pilcher, D.S.O.
Lieut.-Col. E. M. Wilson, C.B., C.M.G., D.S.O.
Lieut.-Col. G. St. S. Thom, C.M.G.
Major Sir E. S. Worthington, C.M.G., M.V.O.

(1) The Minutes of the last meeting were read and confirmed.

(2) The Band accounts for the half year, ending December 31, 1916, were considered and referred to the Band President for fuller information and explanation. A grant of £100 was made to the Band Fund for the current year.

(3) The Royal Army Medical Corps Fund accounts were considered and passed and are attached to these proceedings.

"It was resolved that £800 War Loan, 1915, 4½ per cent., and £600 5 per cent. Exchequer Bonds, 1915, standing in the names of the Trustees of the Royal Army Medical Corps Fund shall be converted into the new War Loan 5 per cent. 1917, and a further £400 of the new War Loan, 1917, be purchased for the Royal Army Medical Corps Fund from the current account and, if possible, the converted Loan and the new purchase shall be inscribed in the names of the Trustee, viz., the Director-General Army Medical Service, the Commandant Royal Army Medical Corps College, and the Deputy-Director Medical Service, London District; but if this is impossible, then Bonds to Bearer shall be accepted.

"That £600 War Loan 4½ per cent., and £1,800 Exchequer Bonds, 1915, standing in the names of the Trustees of the General Relief Fund be converted into the War Loan 5 per cent., 1917, and a further £400 of the 1917 War Loan be purchased from the current account for the General Relief Fund and inscribed in the names of the Trustees." This adjustment will give the Royal Army Medical Corps Fund £1,800, and the General Relief Fund £2,800 of the War Loan.

(4) Sanction was given for the following grants which have been made from the General Relief Fund for the half year ending December 31, 1916:—

No.	Name	Age	District	Grant	Total	Remarks
485	Mrs. E. G. ..	35	London	£4	£4	Earns 18s. a week; requires assistance
486	Mrs. M. K. Q.	44	Tidworth	£4	£12	Ill-health; unable to work

(5) It was noted that a sum of £2,306 0s. 6d. was received in grants from companies and units for the General Relief Fund during the year 1917, a list of contributions is attached hereto.

(6) Sanction was given for the purchase of £1,000 Exchequer Bonds 6 per cent., 1915, which were bought in September last for the General Relief Fund.

(7) As Lieut.-Col. W. W. Pope's four years tenure of office on the Committee has expired, it was resolved on the proposal of Lieut.-Col. Thom, seconded by Lieut.-Col. Wilson, to elect Lieut.-Col. G. S. Mansfield, if he will accept office, as a representative of retired pay officers on the Committee.

(8) It was noted that the £606 1s. 3d. Canada Registered Stock belonging to the General Relief Fund has been handed over to the Treasury on Loan in accordance with a recent Treasury order.

(9) Lieut.-Col. F. W. H. Davie Harris was re-elected Secretary for a period of three years from June, 1917.

(10) It was proposed by the Chairman and seconded by Lieut.-Col. Thom and resolved, that the following resolution shall be submitted to the Annual General Meeting for its consideration: "That as the General Relief Fund is now on a sound financial basis, the time has arrived when it should take its share in the administrative expenses of the Fund, therefore the Committee recommend that one half of the working expenses borne by the Royal Army Medical Corps Fund shall in future be debited to the General Relief Fund." If approved by the Annual General Meeting this resolution will, in future, divide the total working expenses of the Royal Army Medical Corps Fund and the Royal Army Medical Corps Officers' Benevolent Society into three equal divisions between the Royal Army Medical Corps Fund, the General Relief Fund, and the Royal Army Medical Corps Officers' Benevolent Society.

ROYAL ARMY MEDICAL CORPS FUND STATEMENT OF ACCOUNTS FOR 1916.

Receipts.	£	s.	d.	Expenditure.	£	s.	d.
By Balance in Bank, December 31, 1915	323	13	10	Grant to Band	325	0	0
Subscriptions	1,078	15	6	General Relief Fund	80	0	0
Dividends:—				Fire Insurance Q.A.M.H. Chapel	4	5	6
Caledonian Railway (Less Tax)	46	4	1	Royal School for Officers' Daughters	26	5	0
North British Railway (Less Tax)	47	16	4	Easter Card to Russian Medical Staff	5	0	0
Exchequer Bonds, 1915	14	0	4	Purchase of £600 Exchequer Bonds	600	0	0
War Loan	27	0	0	Banker's Charges	0	4	9
				Office Allowance	90	0	0
				Shorthand Writer	1	1	0
				Stationery and Printing	2	17	8
				Furniture	2	9	9
				Postage	2	8	7
				Balance in Bank, December 31, 1916	397	17	10
	£1,537	10	1		£1,537	10	1

Investments (at cost).

	£	s.	d.
Caledonian Railway 4 % Preference Stock	£1,408	0	0
North British Railway 4½ % Preference Stock	1,457	0	0
War Loan, 1915, 4½ %	800	0	0
Exchequer Bonds, 1915, 5 %	600	0	0
	£4,265	0	0

STATEMENT OF ACCOUNTS OF THE GENERAL RELIEF FUND FOR THE YEAR 1916.

Receipts.	£	s.	d.
Balance in hand, December 31, 1915	616	9	1
Grants from Companies and Units	2,306	6	9
Grant from R.A.M.C. Fund	80	0	0
Rebate of Income Tax	16	12	5
Subscriptions and Donations	12	19	0
Lady Saunders and Miss Eastwood	20	0	0
Colonel Noeman Dalton	5	0	0
From a South African	5	0	0
Football Match, Aldershot	66	7	8
Concert, Llandrindod Wells	12	12	9
Royalties on Service Memoirs	0	3	1
Dividends:—			
Canada Registered Stock	16	14	1
East India Railway Debenture Stock	28	10	3
War Loan	20	5	0
Exchequer Bonds, 1915	53	6	3
	£3,290	6	4

Expenditure.	£	s.	d.
Grants to Companies	26	0	0
Union Jack Club	25	4	0
Soldiers' and Sailors' Help Society	5	0	0
Association for Employment of ex-Soldiers	5	0	0
A. and N. Male Nurses Co-operation	5	0	0
Corps of Commissionaires	10	0	0
Record Office Expenses	2	2	0
Transferred to Auxiliary R.A.M.C. Fund	7	0	0
Bankers' Charges	0	19	6
Purchase, Exchequer Bonds, 1915, May 16, 1916	1,800	0	0
,, ,, ,, 1916, October 6, 1916	1,000	0	0
Balance in Bank, December 31, 1916	404	0	10
	£3,290	6	4

Investments (at Cost).

	£	s.	d.
Canada 3½ %, Registered Stock	606	1	3
East India Railway 3½ % Debenture Stock	1,060	0	0
War Loan, 1915, 4½ %	600	0	0
Exchequer Bonds, 1915, 5 %	1,800	0	0
,, ,, 1916, 6 %	1,000	0	0
	£5,066	1	3

STATEMENT OF COMPASSIONATE SCHOOL FUND ACCOUNTS.

Receipts.		£ s. d.	Expenditure.		£ s. d.
Balance in hand, December 31, 1915—			Royal Soldiers' Daughters' Home		40 13 0
Current Account	£87 13 9		Drummond Institute		5 0 0
Deposit Account	200 0 0		Home for Catholic Children		12 0 0
		287 13 9	Balance in hand, December 31, 1916—		
Refund, Royal Soldiers' Daughters' Home		8 14 5	Current Account	£141 10 5	
Interest on Deposit Account		2 15 3	Deposit Account	100 0 0	
					241 10 5
		£299 3 5			£299 3 5

ROYAL ARMY MEDICAL CORPS FUND BALANCE SHEET.

STATEMENT OF ACCOUNTS.

Assets.			£ s. d.
Balance, Pass Book, December 31, 1915	£1,095 16 8	—	
Receipts, Pass Book, 1916	4,002 6 8		
		£5,098 3 4	
Expenditure per Pass Book, December 31, 1916	—	4,150 14 3	
Balance per Pass Book, December 31, 1916			947 9 1
Catholic School Fund Deposit Account	—		100 0 0
Investments, R.A.M.C. Fund—			
,, Caledonian Railway	1,408 0 0	—	
,, North British Railway	1,457 0 0	—	
,, War Loan, 1915	800 0 0	—	
,, Exchequer Bonds, 1915	600 0 0	—	
			4,265 0 0
Investments, General Relief Fund—			
,, Canada Stock	606 1 3	—	
,, East India Railway	1,060 0 0	—	
,, War Loan, 1915	600 0 0		
,, Exchequer Bonds, 1915	1,800 0 0	—	
,, Exchequer Bonds, 1916	1,000 0 0	—	
			5,066 1 3
			£10,378 10 4

Liabilities.	£ s. d.
R.A.M.C. Fund	4,662 17 10
General Relief Fund	5,470 2 1
Compassionate School Fund	241 10 5
Outstanding Cheque	4 0 0
	£10,378 10 4

Examined and found correct, subject to inspection of scrip.

(*Signed*) F. J. JENCKEN, *Surg.-General.*
E. M. WILSON, *Lieut.-Colonel*, R.P.

January 4, 1917

GENERAL RELIEF FUND.

Grants received from Companies and Units during the year 1916.

		£	s.	d.
Aldershot	Nos. A, B, C and No. 1 Companies ..	£500	0	0
Aldershot	No. 2 Company	5	0	0
Netley	Nos. 4 and 5 Companies ..	5	0	0
Cosham	No. 6 Company	20	0	0
Devonport	,, 7 ,,	30	0	0
York	,, 8 ,,	200	0	0
Colchester	,, 9 ,,	5	0	0
Chatham	,, 10 ,,	5	0	0
Shorncliffe	,, 11 ,,	*Nil*		
Woolwich	,, 12 ,,	5	0	0
Edinburgh	,, 13 ,,	2	0	0
Dublin	,, 14 ,,	*Nil*		
Belfast	,, 15 ,,	10	0	0
Cork	,, 16 ,,	4	11	6
Curragh	,, 17 ,,	5	0	0
Rochester Row	,, 18 ,,	3	0	0
Chester	,, 19 ,,	23	13	3
Tidworth	,, 20 ,,	*Nil*		
S. Africa	,, 22 and 23 ,,	27	10	0
Hong Kong	,, 27 ,,	8	0	0
Gibraltar	,, 28 ,,	7	7	0
Mauritius	,, 31 ,,	18	16	8
Egypt	,, 33 ,,	50	0	0
R.A.M.C.—				
Sheffield		5	0	0
Whalley		100	0	0
Lichfield Central Hospital ..		150	0	0
Exeter		2	9	0
Eastbourne		1	13	0
5th Division		31	9	2
Training Centre, Sling ..		100	0	0
,, ,, Farnham ..		25	0	0
,, ,, Limerick ..		10	0	0
Deccan British War Hospital		2	13	4
R.A.M.C., Malta—				
No. 1 Company		5	0	0
St. David Hospital		10	0	0
Forrest ,, ...		1	0	0
Cottonera ,, ...		5	2	0
Spinola ,, ...		5	0	0
Valletta ,, ...		15	0	0
Tigne ,, ...		3	0	0
Tuffiala ,, ...		5	0	0
St. John's ,, ...		5	0	0
St. Andrew's ,, ...		10	0	0
,, Serjeants' Mess		2	2	0
St. George's Hospital ..		20	0	0
No. 1 General Hospital ..		6	0	0
,, 2 ,, ,, ..		10	0	0
,, 3 ,, ,, ..		4	4	9
,, 4 ,, ,, ..		6	1	0
,, 5 ,, ,, ..		10	0	0
,, 6 ,, ,, ..		12	14	0
,, 7 ,, ,, ..		10	0	0
,, 8 ,, ,, ..		1	0	0
,, 9 ,, ,, ..		13	15	0
,, 10 ,, ,, ..		11	13	0
,, 11 ,, ,, ..		10	0	0

	£	s.	d.
No. 12 General Hospital ..	£5	0	0
,, 13 ,, ,, ..	3	11	8
,, 17 ,, ,, ..	10	10	0
,, 18 ,, ,, ..	2	5	0
,, 19 ,, ,, ..	20	0	0
,, 21 ,, ,, ..	10	5	0
,, 22 ,, ,, ..	14	8	3
,, 23 ,, ,, ..	5	0	0
,, 26 ,, ,, ..	8	0	0
,, 28 ,, ,, ..	5	0	0
,, 29 ,, ,, ..	16	0	0
,, 30 ,, ,, ..	6	0	0
,, 31 ,, ,, ..	80	0	6
,, 39 ,, ,, ..	20	0	0
No. 1 Casualty Clearing Station	10	0	0
,, 2 ,, ,, ,,	3	16	0
,, 3 ,, ,, ,,	5	0	0
,, 4 ,, ,, ,,	3	0	0
,, 6 ,, ,, ,,	5	0	0
,, 9 ,, ,, ,,	2	15	0
,, 10 ,, ,, ,,	5	12	5
,, 11 ,, ,, ,,	7	2	0
,, 12 ,, ,, ,,	3	11	8
,, 13 ,, ,, ,,	7	10	0
,, 16 ,, ,, ,,	16	19	0
,, 18 ,, ,, ,,	4	7	10
,, 19 ,, ,, ,,	20	0	0
,, 22 ,, ,, ,,	12	6	0
,, 23 ,, ,, ,,	5	0	0
,, 27 ,, ,, ,,	2	2	6
,, 28 ,, ,, ,,	10	0	0
,, 30 ,, ,, ,,	17	0	0
,, 31 ,, ,, ,,	4	18	0
,, 32 ,, ,, ,,	1	18	3
,, 33 ,, ,, ,,	10	16	6
,, 14 ,, ,, ,,	3	15	0
No. 2 Stationary Hospital ..	7	3	4
,, 5 ,, ,, ..	2	10	0
,, 10 ,, ,, ..	10	0	0
,, 11 ,, ,, ..	20	0	0
,, 12 ,, ,, ..	8	1	0
,, 14 ,, ,, ..	1	0	0
,, 20 ,, ,, ..	8	15	0
,, 21 ,, ,, ..	10	0	0
,, 23 ,, ,, ..	5	0	0
No. 41042 Ambulance Trains	3	7	1
No. 1 Cavalry Field Ambulance	6	0	0
,, 2 ,, ,, ,,	1	0	0
,, 4 ,, ,, ,,	2	10	0
,, 5 ,, ,, ,,	2	3	0
,, 7 ,, ,, ,,	5	0	0
No. 5 Field Ambulance ..	41	0	0
,, 6 ,, ,, ..	3	11	6
,, 8 ,, ,, ..	10	10	0
,, 11 ,, ,, ..	8	6	0
,, 14 ,, ,, ..	4	0	0
,, 15 ,, ,, ..	20	0	0
,, 16 ,, ,, ..	7	3	4
,, 18 ,, ,, ..	3	11	8
,, 19 ,, ,, ..	7	2	0
,, 21 ,, ,, ..	3	10	0
,, 23 ,, ,, ..	10	10	0

No. 27 Field Ambulance	..	£14	2	0	No. 67 Field Ambulance	..	£5	0	0
,, 28 ,, ,,	..	6	12	8	,, 71 ,, ,,	..	5	0	0
,, 30 ,, ,,	..	17	8	10	,, 74 ,, ,,	..	3	3	0
,, 32 ,, ,,	..	2	0	0	,, 77 ,, ,,	..	10	0	0
,, 33 ,, ,,	..	16	10	0	,, 79 ,, ,,	..	8	0	0
,, 35 ,, ,,	..	7	0	0	,, 80 ,, ,,	..	4	0	0
,, 36 ,, ,,	..	7	0	0	,, 96 ,, ,,	..	30	0	0
,, 48 ,, ,,	..	3	3	0	,, 102 ,, ,,	..	5	0	0
,, 54 ,, ,,	..	5	0	0					
,, 55 ,, ,,	..	15	0	0					
,, 58 ,, ,,	..	7	3	0	Total		£2,306	6	9
,, 62 ,, ,,	..	9	18	7					

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

PROCEEDINGS OF A COMMITTEE MEETING HELD AT THE WAR OFFICE ON THURSDAY, JANUARY 18, 1917, IN ROOM 356.

Present:

Surgeon-General M. W. Russell, C.B., Vice-President, in the Chair.
Surgeon-General Sir David Bruce, C.B., F.R.S.
Colonel E. M. Pilcher, D.S.O.
Lieut.-Colonel E. M. Wilson, C.B., C.M.G., D.S.O.

(1) The Minutes of the last Meeting were read and confirmed.

(2) The Accounts for 1916, together with the Auditors' certificate, were considered and passed and attached to these proceedings.

(3) The attached report for the year 1917 was adopted.

(4) Sanction was given for the grants of £10 each made by the Secretary under Rule 31 to:—

The orphan daughter of Deputy-General E. W. B.
The two orphans of Major C. J. H.

(5) It was resolved to purchase £200 of the new War Loan 1917 5 per cent, from the current account, also to convert £200 Exchequer Bonds 5 per cent. 1915 into the new War Loan, which is now standing in the names of the Trustees.

(6) Lieut.-Col. F. W. H. Davie Harris was re-elected Secretary for the year from June, 1917.

REPORT OF THE COMMITTEE FOR THE YEAR 1916.

(1) The number of subscribers for the year was 170 and the amount of subscriptions received was £178 1s.

(2) A sum of £104 12s. 9d. was received as a rebate of Income Tax.

(3) A donation of £50 was received from the Medical Insurance Agency, also £5 each from Mrs. A. F. Macbean, and Colonel H. H. Norman.

(4) The total receipts amounted to £920 19s. 7d.

(5) The total expenditure amounted to £1,090 19s. 7d.

(6) Twenty-seven applicants representing forty-three orphans were granted £725.

F. W. H. DAVIE HARRIS, *Lieut.-Col.*
Secretary.

ROYAL ARMY MEDICAL CORPS COMFORTS FUND.

THE HONORARY SECRETARY'S REPORT FOR 1916.

AT a meeting held in January, 1916, Lady Sloggett and the Central Ladies' Committee for Royal Army Medical Corps Comforts decided, owing to lack of funds, to cease sending out, during the spring and summer months, their usual bales of comforts to the personnel of the Corps overseas. Accordingly from the end of January parcels to Prisoners of War only were despatched. By this time all the men of the Corps who had been interned in Germany had been repatriated and there remained on the Committees' list only the names of a dozen men in Turkish prison camps. During the summer months the latter were very kindly "adopted" by different ladies until the packing-rooms of the Committee were re-opened early in October, when work was resumed. Since then it has been carried on as in the two previous years. The number of prisoners has considerably increased during the autumn, and each one,

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

STATEMENT OF ACCOUNTS FOR 1916.

RECEIPTS.	£	s.	d.
To Balance at Bankers, January 1, 1916	620	19	5
,, Subscriptions	178	1	0
,, Rebate of Income Tax	104	12	9
,, Donations—			
Medical Insurance Agency	50	0	0
Mrs. A. F. Macbean	5	0	0
Col. H. H. Norman	5	0	0
,, Dividends—			
North Eastern Railway 3 % Debenture Stock (*less* tax £36 4s. 11d.)	163	14	7
London and North Western Railway 3 % Debenture Stock (*less* tax £36 4s. 8d.)	163	15	2
Midland Railway 2½ % Debenture Stock (*less* tax £29)	131	0	0
Caledonian Railway 4 % Debenture Stock (*less* tax £23 8s. 9d.)	87	15	3
Consols	26	2	10
Exchequer Bonds 5 %	5	18	0
	£1,541	19	0

EXPENDITURE.	£	s.	d.
By Grants	725	0	0
,, Transfer to Auxiliary R.A.M.C. Funds	60	10	0
,, Bankers' Charges, including Subscription paid in error	6	5	6
,, Purchase of £100 Exchequer Bonds, 1915	200	0	0
,, Registration of same	0	2	0
,, Auditor's Fee	1	1	0
,, Office Allowance	90	0	0
,, ,, Furniture	2	9	9
,, Stationery and Printing	2	17	7
,, Postage	2	8	8
,, Balance at Bankers, December 31, 1916	451	4	6
	£1,541	19	0

INVESTMENTS.	£	s.	d.
London & North Western Railway 3% Debenture Stock	6,667	0	0
North Eastern Railway 3 % Debenture Stock	6,666	0	0
Midland Railway 2½ % Debenture Stock	6,400	0	0
Caledonian Railway 4 % Debenture Stock	2,780	0	0
Consols	1,327	7	9
Exchequer Bonds, 1915	200	0	0
	£24,040	7	9

We have compared the above statement with the books and vouchers relating thereto, and certify it to be correct. We have verified the Bank Balance and the Investment in Consols, and have inspected the Certificates of the other Investments.

Portland House,
Basinghall Street, E.C.
January 5, 1917.

(*Signed*) EVANS, PIERSON & CO.,
Chartered Accountants.

ROYAL ARMY MEDICAL CORPS COMFORTS FUND.

STATEMENT OF ACCOUNTS FOR 1916.

RECEIPTS.	£	s.	d.	EXPENDITURE.	£	s.	d.
Balance in hand, December 31, 1915	263	12	1	Gamage, Ltd.	131	16	11
Grants and Donations, 1916	1,215	5	1	Army and Navy Stores	321	18	6
				Derry and Toms, Ltd.	408	7	0
				Empire Service	438	1	10
				Peter Robinson, Ltd.	16	13	6
				Watford Manufacturing Company	13	17	4
				G. W. Dray and Son	9	11	0
				Drayton Paper Mills	4	14	0
				N. Hants Printing Company	3	6	10
				Phillips and Co.	5	3	5
				Ayrton Saunders and Co.	0	12	9
				L. and S.W. Railway	15	8	6
				Mrs. Morgan: Imprest Account	*28	0	0
				Postage	2	0	0
				Bankers' Charges	0	17	8
				Incidental Expenses	4	10	8
				Advertising	13	8	6
				Balance in hand, December 31, 1916	60	14	9
	£1,478	17	2		£1,478	17	2

* Portage. Rail Expenses. Carriage of Parcels. Groceries for Prisoners of War. Balance in hand, 18s. 4d.

Examined and found correct,
(*Signed*) EDMOND T. GANN.

January 22, 1917.

whether he belongs to a Regular or Territorial unit, has had three parcels of food and clothing despatched each fortnight from the Comforts Fund.

A total of 349 bales of an average weight of 55 lb. have been sent out, 220 of these to units in various Mediterranean theatres of War, 129 to those serving in France, and in addition 151 parcels of 11 lb. weight each to prisoners of War, making a total of 500 parcels during 1916.

Many grateful acknowledgments have been received from the various recipients, including prisoners of War.

While the several Branch Depôts of the Comforts Fund in England and Scotland have helped splendidly both in sending clothing and money, the Committee find it increasingly difficult to continue the work, as the quantity of gifts of comforts in all forms have decreased considerably during the year, while the numbers of medical units to be supplied have largely increased. The expenses of the Fund have, therefore, been greater this year, as it has been necessary to purchase the greater part of the articles sent out. The Committee exceedingly regrets that they have lately been unable to comply with a considerable number of requisitions, owing to the lack of funds.

The following are a few of the principal articles dispatched :—

Shirts	1,136	Games	6,244
Pants and vests ..	3,822	Chocolate and sweets	733 lb.
Socks	3,424 pairs	Puddings and cakes..	2,321 ,,
Handkerchiefs ..	6,399	Cigarettes	3,127 packets
Towels	5,196	Writing paper ..	25,816 ,,
Soap	12,646 cakes		

besides various foods for the prisoners of war, such as tinned meats, fish, vegetables, jams and fruits, biscuits, cheese, butter and dripping, also tea, sugar, soup squares, oatmeal, cornflour, curry powder, etc., etc. Each imprisoned man is also supplied with a complete suit of clothing, viz , trousers, jacket, greatcoat, hat, etc., as well as boots, shoes and underclothing.

The Comforts Fund has been registered under the War Charities Act and is also an authorized Society under the Central Prisoners of War Committee.

Lieut.-Col. F. W. H. Davie Harris, who kindly acts as Treasurer for the Fund, will submit the balance sheet for publication in the ROYAL ARMY MEDICAL CORPS JOURNAL.

The ladies who have helped actively in the packing of comforts are: Lady Bruce, Lady Babtie, Mesdames Macpherson, Russell, Maher, Geddes, Treherne, Robinson, Harrison, Archer, Birrell, Brereton, McGrigor, Murray Irwin, Nash, Ellis, Scott, Brown and Windle, Miss Burnett.

Since December 1 a working party has been organized which meets once a week to make shirts, etc., the necessary materials being purchased from subscriptions raised amongst the workers.

Lady Sloggett and the Committee wish to thank all those who have so generously helped them in the past by donations, both in money and kind, and they hope for a continuance of their kind support to enable them to carry on their work.

Parcels of comforts should be sent to the Honorary Secretary: Mrs. C. K. Morgan, Royal Army Medical Corps Comforts, Royal Army Medical College, Grosvenor Road, London, SW., and cheques to Lieut.-Col. F. W. H. Davie Harris, 124, Victoria Street, London, S.W.

(Signed) ELEANOR E. B. MORGAN,
Honorary Secretary.

MARRIAGE.

LOUGHNAN--MANLY.—On December 27, 1916, at the Church of the Three Patrons, Rathgar, Dublin, by the Very Reverend Charles Canon Malone, P.P., assisted by the Rev. T. A. Fitzgerald, O.F.M., Captain W. F. M. Loughnan, M.C., R.A.M.C., son of the late J. M. Loughnan, of Sion Villa, Kilkenny, to Eileen, fourth daughter of Joseph Manly and Mrs. Manly, of Frankfort Avenue, Rathgar, Dublin.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints: As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	6 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 3d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

All Applications for Advertisements to be made to—

G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from N. D. Bardswell, Esq., M.V.O.: Colonel H. H. Tooth, C.M.G.: Major J. E. H. Gatt; Captains W. W. Wagstaffe, W. J. Adie, D. Thomson, T. J. Mackie, E. J. Storer, A. Abrahams, G. Ward; Lieutenant and Quartermaster D. G. Mootham; G. Cooper, Esq., M.D.: and J. F. Colyer, Esq.

The following publications have been received:—

British: The British Journal of Surgery, The Hospital, The Journal of Tropical Medicine and Hygiene, Journal of the Royal Naval Medical Service, The Medical Journal of Australia, Tropical Diseases Bulletin, The Medical Press and Circular, United States Naval Medical Bulletin, The Quarterly Journal of Medicine, Annual Report of the Medical Officer of Health, Khartoum, The Lancet, Guy's Hospital Gazette, The Practitioner, Seventeenth Stationary Hospital Gazette, The Indian Medical Gazette, The Journal of State Medicine, Journal of the United Service Institution of India.

Foreign: The Journal of Infectious Diseases, United States Public Health Service, Tidskrift i Militär Hälsovard, Bulletin de l'Institut Pasteur, Office International d'Hygiène Publique, Journal of Agricultural Research, L'Ospedale Maggiore, Bulletin de la Société de Pathologie Exotique.

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

MARCH, 1917.

EXTRACTS FROM THE "LONDON GAZETTE."

CENTRAL CHANCERY OF THE ORDERS OF KNIGHTHOOD,
Lord Chamberlain's Office,
St. James's Palace, S.W.
February 1, 1917.

The King has been graciously pleased to give orders for the following appointment to the Most Honourable Order of the Bath, for valuable services rendered in connexion with Military Operations in the Field. The appointment to date from January 1, 1917:—

To be Additional Member of the Military Division of the Third Class, or Companion, of the said Most Honourable Order:—

Col. (Temp. Surg.-Gen.) George Douglas Hunter, C.M.G., D.S.O., Army Medical Service.

War Office,
February 1, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned Honours and Rewards for valuable services rendered in connexion with Military Operations in the Field, with effect from January 1, 1917, inclusive:—

To be Companions of the Distinguished Service Order:—

Major (Temp. Lieut.-Col.) Wallace Benson, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Francis Ernest Gunter, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Charles Arthur Johnston, C.I.E., M.B., Indian Medical Service.
Capt. Gerald Joseph Keane, M.D., Royal Army Medical Corps.
Lieut.-Col. John McKie, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Gerard William Tate, M.B., Royal Army Medical Corps.
Lieut.-Col. Reginald George Turner, F.R.C.S., Indian Medical Service.

SOUTH AFRICAN FORCES.

Lieut.-Col. Henry Alford Moffat, South African Medical Corps.
Temp. Lieut.-Col. Charles Herold Muller, M.B., South African Medical Corps.
Lieut.-Col. William Booth Skinner, M.B., South African Medical Corps.
Lieut.-Col. John Herbert Whitehead, South African Medical Corps.

Awarded the Military Cross.

Capt. Robert Siggins Kennedy, M.B., Indian Medical Service.
Capt. Conyngham Vernon Thornton, M.B., Royal Army Medical Corps.

SOUTH AFRICAN FORCES.

Capt. Harry Fayle, M.D., South African Medical Corps.

Awarded the Distinguished Conduct Medal.

2nd Acting Serjt.-Major E. G. Gray, Royal Army Medical Corps.

Awarded the Meritorious Service Medal.

No. 41641 Serjt.Major G. Brown, Royal Army Medical Corps.
No. 18432 Qmr.-Serjt. (Acting Serjt.-Major) G. F. Pearce, Royal Army Medical Corps.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

Chancery of the Order, St. John's Gate,
Clerkenwell, London, E.C.
January 30, 1917.

The King has been graciously pleased to sanction the following promotion in, and appointments to, the Order of the Hospital of St. John of Jerusalem in England :—

KNIGHTS OF GRACE.

Col. Eustace Augustus Burnside, M.R.C.S., Army Medical Service.
Surg.-Gen. Francis John Jencken, M.B., D.P.H.

War Office,
February 8, 1917.

The following dispatch has been received by the Secretary of State for War from Lieut.-Gen. The Hon. J. C. Smuts, Commanding-in-Chief, East African Force :—

General Headquarters,
East African Force,
November 22, 1916.

SIR,—In accordance with the last paragraph of my dispatch dated October 27, 1916, I have the honour to bring to notice the names of those whom I recommend for Meritorious Service in the Field.

I have the honour to be, Sir,
Your obedient servant,
J. C. SMUTS, *Lieut.-General,*
Commander-in-Chief, East African Force.

ROYAL ARMY MEDICAL CORPS.

Capt. (Temp. Major) J. A. Manifold, M.B., Royal Army Medical Corps.
Temp. Capt. E. A. Gates, M.D.
Qmr. and Hon. Lieut. G. A. Collier.
No. 30975 Staff-Serjt. (Acting Qmr.-Serjt.) C. R. Lockhart.
No. 11236 Serjt. B. A. Embelin.
No. 10555 Serjt. W. C. Holden.
No. 9311 Cpl. J. W. Davies.
No. ?3358 Pte. (Acting Lance-Cpl.) D. Savage.
No. 51634 Pte. A. Mackenzie.
No. 26368 Serjt. J. T. P. Brown.
No. 16 Cpl. G. A. Lynch.
No. 51 Pte. N. L. Monaghan.
No. 69845 Pte. S. C. Radford.

CENTRAL CHANCERY OF THE ORDERS OF KNIGHTHOOD.

Lord Chamberlain's Office,
St. James's Palace,
February 6, 1917.

The King has been graciously pleased to give orders for the following promotion in, and appointment to, the Most Honourable Order of the Bath. The promotion and appointment to date from January 1, 1917 :—

To be Ordinary Member of the Military Division of the Third Class, or Companion, of the said Most Honourable Order :—

Lieut.-Col. Patrick Balfour Haig, M.B., Indian Medical Service.

War Office,
February 13, 1917.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officer to be Companion of the Distinguished Service Order in recognition of his gallantry and devotion to duty in the Field:—

SOUTH AFRICAN FORCE.

Major John Edward Briscoe, South African Medical Corps.

For conspicuous gallantry and devotion to duty. Although himself wounded, he continued to tend wounded men under very heavy fire. He set a splendid example of courage and coolness throughout.

His Majesty the King has been graciously pleased to award a Bar to the Military Cross to the undermentioned Officer:—

Temp. Capt. William Kenneth Mackenzie, M.C., M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in conducting a hazardous and very difficult enterprise for the rescue of wounded from dug-outs in the newly captured enemy trenches. He set a splendid example throughout.

(The award of the Military Cross was published in the *London Gazette*, dated October 20, 1916).

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the Field:—

Temp. Lieut. James Lang Cochrane, M.B., Royal Army Medical Corps, attached Gloucestershire Regiment.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending the wounded under heavy fire. He has on many previous occasions done fine work.

Capt. Arthur George Fisher, M.B., Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He went forward to the front line under very heavy fire to locate some wounded men whom he later succeeded in rescuing. He had previously done fine work.

Temp. Capt. Arthur John Rushton O'Brien, M.B., Assistant Medical Service, attached Gold Coast Regiment.

For conspicuous gallantry and devotion to duty. He repeatedly dressed and tended wounded men under very heavy fire. He set a splendid example of courage and coolness throughout.

Temp. Capt. James Edmund Rutherfurd, M.B., Royal Army Medical Corps, attached Royal Irish Regiment.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in dressing the wounded under very heavy fire. He has on many previous occasions done fine work.

Temp. Lieut. John Black Stevenson, M.B., Royal Army Medical Corps, attached Liverpool Regiment.

For conspicuous gallantry and devotion to duty. On four separate occasions he personally conducted stretcher-bearers through very heavy fire to succour wounded men. Later, although himself wounded, he continued to carry on his work.

Temp. Capt. Roger Llewellyn Williams, Royal Army Medical Corps, attached South Staffs. Regiment.

For conspicuous gallantry and devotion to duty. He displayed marked courage and determination in tending the wounded under very heavy fire. He has on many previous occasions done fine work.

SOUTH AFRICAN CONTINGENT.

Capt. Kenneth Alexander Gilchrist, South African Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending the wounded under very heavy fire. He set a fine example to those about him.

With reference to the announcement of the award of the Distinguished Conduct Medals in the Honours Supplement to the *London Gazette*, dated January 1, 1917, the following are the acts of gallantry for which the decorations have been awarded:—

No. 117 Pte. T. W. Brown, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in evacuating several wounded men and extricating some wounded horses under heavy fire.

No. 69805 Pte. M. Charnock, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in extricating wounded men from a dug-out, which had been blown in by a shell.

No. 1914 Serjt. E. Dugmore, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He has on many occasions displayed great courage and determination in rescuing wounded men under heavy fire.

No. 50850 Cpl. T. F. Lyttle, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination on many occasions under heavy fire, and set a splendid example to the men under him.

No. 57738 Cpl. G. Noakes, Royal Army Medical Corps.

For conspicuous ability and devotion to duty. He has shown untiring zeal at all times.

No. 1129 Serjt. J. Powis, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He has performed consistent good work throughout, and has on many occasions shown great courage and coolness under heavy fire.

No. 72297 Staff.-Serjt. C. Sanders, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination, under very heavy fire, in conducting bearer parties to and fro to the advanced post, until wounded himself.

No. 39862 Serjt.-Major, C. W. Tapson, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He has performed consistent good work throughout, and has on many occasions displayed great courage and determination in tending the wounded, under heavy fire.

No. 11827 Serjt. W. White, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He showed great courage and determination in tending the wounded under heavy fire, working continuously for seventy hours.

His Majesty the King has been graciously pleased to award the Meritorious Service Medal to the undermentioned Warrant Officers, Non-commissioned Officers and Men, in recognition of valuable services rendered with the Armies in the Field during the present War:—

No. 27258 Serjt.-Major J. P. Bent, Royal Army Medical Corps.
No. 53046 Serjt. J. S. Bowring, Royal Army Medical Corps.
No. 9824 Acting Cpl. W. S. Chevalier, Royal Army Medical Corps.
No. 14888 Staff-Serjt. H. Currell, Royal Army Medical Corps.
No. 53437 Serjt. J. Graham, Royal Army Medical Corps.
No. 1042 Staff-Serjt. W. G. H. Greenfield, Royal Army Medical Corps.
No. 380 Serjt. F. S. Greenslade, Royal Army Medical Corps.
No. 12052 Staff-Serjt. (Acting Staff-Serjt. Major) F. C. Halkett, Royal Army Medical Corps.
No. 29989 Acting Cpl. S. Heley, Royal Army Medical Corps.
No. 32 Staff-Serjt. H. James, Royal Army Medical Corps.
No. 6231 Serjt. (Acting Serjt.-Major) P. J. Martin, Royal Army Medical Corps.
No. 15843 Qmr.-Serjt. (Acting Serjt.-Major) W. Stokes, Royal Army Medical Corps.
No. 39480 Staff-Serjt. (Acting Qmr.-Serjt.) F. F. Turner, Royal Army Medical Corps.
No. 23666 Pte. T. Waterhouse, Royal Army Medical Corps.

AMENDMENTS.

Corrections to *London Gazette* announcements:—

November 11, 1916.

Meritorious Service Medal.

For 107 Serjt. S. G. De Barre, Royal Army Medical Corps, *read* 107 Staff-Serjt. S. G. De Barre, Royal Army Medical Corps.

Bar to Meritorious Service Medal.

The undermentioned Non-commissioned Officer has been awarded a Bar to the Meritorious Service Medal ;—

No. 27253 Serjt. J. Orr, Royal Army Medical Corps.

The award of the Meritorious Service Medal appeared in the *London Gazette*, dated November, 11, 1916.

The following corrections are made in the *London Gazette* announcements of various dates :—

January 1, 1917.

Military Cross Award.

Page 35, *for* Temp. Capt. David Hamilton Hadden, M.B., *read* Temp. Capt. David Hamilton Hadden, M.B., Royal Army Medical Corps.

CHANCERY OF THE ORDER OF ST. MICHAEL AND ST. GEORGE.

Downing Street,
February 15, 1917.

The King has been graciously pleased to give directions for the following appointment to the Most Distinguished Order of St. Michael and St. George, for services rendered in connection with military operations in the Field :—

To be an Additional Member of the Third Class, or Companion, of the said Most Distinguished Order.

Colonel Patrick Hehir, C.B., M.D., F.R.C.S., Indian Medical Service.

War Office,
February 15, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for Distinguished Service in the Field, with effect from January 1, 1917, inclusive, except where otherwise stated :—

TO BE BREVET-LIEUTENANT-COLONEL.

Major A. W. C. Young, M.B., Indian Medical Service (with effect from June 3, 1916, inclusive).

AWARDED BAR THE MILITARY CROSS.

Temp. Capt. Allen Coulter Hancock, M.C., Royal Army Medical Corps.

AWARDED THE MERITORIOUS SERVICE MEDAL.

No. 19604 Serjt. R. Pollock, Royal Army Medical Corps.

War Office,
February 15, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned Honours and Rewards for valuable services rendered in connexion with the War, with effect from January 1, 1917, inclusive :—

TO BE BREVET-COLONELS.

Lieut.-Col. W. G. Beyts, Royal Army Medical Corps.
Lieut.-Col. L. P. More, MB., Royal Army Medical Corps.

TO BE BREVET LIEUTENANT-COLONEL.

Major F. A. F. Barnardo, M.D., F.R.C.S., Indian Medical Service.

War Office,
February 15, 1917.

The following are among the decorations and medals awarded by the Allied Powers at various dates to the British Forces for distinguished services rendered during the course of the campaign :—

His Majesty the King has given unrestricted permission in all cases to wear the decorations and medals in question.

DECORATIONS AND MEDALS CONFERRED BY FIELD-MARSHALL HIS IMPERIAL MAJESTY THE EMPEROR OF RUSSIA.

(*September* 12, 1916).

Order of St. Anne, 3rd Class (with Swords).

Col. Gerald Cree, C.M.G., Army Medical Service.

Medal of St. George, 3rd Class.

No. 34877 Pte. (Acting-Lance-Cpl.) Arthur James Taylor, Royal Army Medical Corps.

Medal of St. George 4th Class.

No. 39442 Pte. James Lindsay, Royal Army Medical Corps, attached South Staffordshire Regiment.

No. 45659 Cpl. Sydney Allen Smith. Royal Army Medical Corps.

No. 66358 Pte. Frank Wills, Royal Army Medical Corps.

Cross of St. George, 4th Class.

No. 78 Private Graham Franklin Nicholson, Royal Army Medical Corps.

Medal of St. George, 4th Class.

No. 2017 Pte. Alfred James Large, Welsh Field Ambulance, Royal Army Medical Corps.

Cross of St. George, 3rd Class.

No. 69845 Private Stephen Charles Radford, Royal Army Medical Corps, attached Gold Coast Regiment.

DECORATIONS AND MEDALS CONFERRED BY HIS MAJESTY THE KING OF SERBIA.
(*September and October*, 1916).

Order of the White Eagle, 3rd Class (with Swords).

Lieut.-Col. (Temp. Col.) Alfred Ernest Conquer Keble, D.S.O., Royal Army Medical Corps.

Order of the White Eagle, 4th Class (with Swords).

Major Robert Welland Knox, D.S.O., M.B., Indian Medical Service.

Major Roy Stanley McGregor, Australian Army Medical Corps.

Lieut.-Col. John Robert Whait, M.B., Royal Army Medical Corps.

Order of the White Eagle, 5th Class (with Swords).

Capt. Heerajee Jehangir Manockjee Cursetjee, M.B., Indian Medical Service.

Capt. James Gerald Fayrer Hosken, Royal Army Medical Corps.

Capt. Wentworth Roland Caneagh Mainwaring, Australian Army Medical Corps, attached Australian Light Horse.

Temp. Capt. Reginald Anson Mansell, M.B., Royal Army Medical Corps.

Capt. Robert Proudfoot, M.D., Royal Army Medical Corps.

Capt. Hugh George Trayer, M.B., Royal Army Medical Corps.

Capt. (Temp. Lieut.-Col.) Henry Wade, M.D., F.R.C.S., Royal Army Medical Corps.

Cross of Karageorge, 1st Class (with Swords).

No. 150 Pte. Alexander Prentice McInnes, Royal Army Medical Corps,

Cross of Karageorge, 2nd Class (with Swords).

No. 1596 Serjt. Gavin Greig, Field Ambulance, Royal Army Medical Corps.

No. 1867 Cpl. George Henry Johnson, Mounted Brigade Field Ambulance, Royal Army Medical Corps.

No. 2226 Pte. Hugh Llewellyn Jones, Welsh Field Ambulance, Royal Army Medical Corps.

No. 16573 Serjt.-Major Robert Stewart Nichol, Casualty Clearing Station, Royal Army Medical Corps.

Gold Medal.

No. 26486 Pte. Alfred Richard Baker, Royal Army Medical Corps.

No. 3241 Pte. Alfred Albert Baldwin, Royal Army Medical Corps.

No. 170 Pte. Herbert James Bolwell, Royal Army Medical Corps.

No. 114 Acting Lance-Cpl. Arthur Douglas Davis, Royal Army Medical Corps.

No. 39738 Pte. Andrew Gowans, Royal Army Medical Corps.

No. 1555 Pte. Moses Martin, Field Ambulance, Royal Army Medical Corps.

Silver Medal.

No. 55 Pte. Ernest Albert Beard, Mounted Brigade, Field Ambulance, Royal Army Medical Corps.

No. 1565 Pte. William Campbell, Mounted Brigade Field Ambulance, Royal Army Medical Corps.

No. 53051 Pte. (now acting Cpl.) Michael Carroll, Casualty Clearing Station, Royal Army Medical Corps.

No. 1607 Pte. Albert William Francis, Mounted Brigade, Field Ambulance, Royal Army Medical Corps.

No. 126 Pte. Frank Kenchington, Field Ambulance, Royal Army Medical Corps.
No. 40340 Pte. George Murdoch, Field Ambulance, Royal Army Medical Corps.
No. 1915 Lance-Cpl. William Scott, Field Ambulance, Royal Army Medical Corps.
No. 34 Pte. Stephen Vincent, Mounted Brigade, Field Ambulance, Royal Army Medical Corps.

August 27, 1916.

Order of the White Eagle, 2nd Class (with Swords).

Surg.-Gen. Francis Harper Treherne, C.M.G., F.R.C.S.

Order of the White Eagle, 4th Class (with Swords).

Major Richard James Bradley, M.B., Indian Medical Service.
Lieut.-Col. (Temp. Col.) Denis Joseph Collins, M.D., Royal Army Medical Corps.
Major Walter Scott Patton, M.B., Indian Medical Service.

Order of the White Eagle, 5th Class (with Swords).

Capt. (Temp. Major) Edmund Tytler Burke, M.B., Royal Army Medical Corps, Special Reserve.
Capt. Herman Falk, M.B., Indian Medical Service.
Capt. Edward Slade Goss, Indian Medical Service.
Capt. Vivian Bartley Green-Armytage, Indian Medical Service.
Lieut. Nilkanth Sheiram Jatar, Indian Medical Service.

Cross of Karageorge, 1st Class (with Swords).

Sub-Assist. Surg. Rawail Singh, Indian Subordinate Medical Department (attached Sikhs).

Cross of Karageorge, 2nd Class (with Swords).

No. 38428 Serjt. Francis Sullivan, Field Ambulance, Royal Army Medical Corps.

Gold Medal.

No. 1916 Pte. George Stanley Elcock, Royal Army Medical Corps (attached Somersetshire Light Infantry).

Silver Medal.

No. 56710 Pte. John Burton, Royal Army Medical Corps.
No. 9529 Pte. William Lomax, Royal Army Medical Corps.

Order of the White Eagle, 4th Class (with Swords).

Lieut.-Col. Richard Reginald Sleman, M.D., Royal Army Medical Corps.

Order of the White Eagle, 5th Class (with Swords).

Temp. Capt. Joseph Arthur Arkwright, M.D., Royal Army Medical Corps.
Capt. Robert Carlyle Carlyle, M.B., Royal Army Medical Corps.
Capt. (temp. Major) Edward Leopold Rowse, M.B., Royal Army Medical Corps.

Gold Medal.

No. 25282 Pte. William Brammall, Royal Army Medical Corps.
No. 1461 Pte. Edward Douglas Browne, Royal Army Medical Corps.
No. 50965 Pte. Albert Davies, Royal Army Medical Corps.
No. 56917 Pte. Thomas Haney, Royal Army Medical Corps.
No. 1346 Pte. Henry James Matthews, Royal Army Medical Corps.
No. 44461 Pte. Reginald Morgan, Royal Army Medical Corps.
No. 58628 Pte. Charles Sydney Murgatroyd, Royal Army Medical Corps
No. 29405 Pte, Harold Murgatroyd, Royal Army Medical Corps.
No. 45412 Pte. George Noble, Royal Army Medical Corps.
No. 58550 Pte. James Henry Stansfield, Royal Army Medical Corps.
No. 58534 Pte. James Thorp, Royal Army Medical Corps.

Silver Medal.

No. 1059 Pte. Charles Stanley Ball, Royal Army Medical Corps.
No. 1793 Pte. William Baxter, Royal Army Medical Corps.
No. 58502 Pte. Albert Edward Hamshaw, Royal Army Medical Corps.
No. 49865 Pte. John Heeley, Royal Army Medical Corps.
No. 59244 Pte. John Kerr Kennedy, Royal Army Medical Corps.
No. 647 Pte. Herbert Frank Lloyd, Royal Army Medical Corps.
No. 58485 Pte. Alfred Edmund Owen, Royal Army Medical Corps.

No. 56632 Pte. Reginald Leonard Brinsley Penny, Royal Army Medical Corps.
No. 58557 Pte. William Proctor, Royal Army Medical Corps.
No. 58549 Pte. John William Whittaker, Royal Army Medical Corps.
No. 61439 Pte. Fred Wigglesworth, Royal Army Medical Corps.

War Office,
February 19, 1917.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the field to the undermentioned Non-commissioned Officers and Men :—

No. 39311 Pte. J. Anderson, Royal Army Medical Corps.
No. 33101 Pte. R. Arigho, Royal Army Medical Corps.
No. 1994 Pte. G. A. Atkins, Royal Army Medical Corps.
No. 103705 Pte. J. Atkinson, Royal Army Medical Corps.
No. 61934 Serjt. R. W. Banks, Royal Army Medical Corps.
No. 9698 Pte. J. Bee, Royal Army Medical Corps.
No. 41618 Cpl. (Acting-Serjt.) J. Bloom, Royal Army Medical Corps.
No. 73365 Pte. W. J. Brookes, Royal Army Medical Corps.
No. 97128 Pte. (Acting-Cpl.) A C. Cardy, Royal Army Medical Corps.
No. 58245 Serjt. J. J. Clarke, Royal Army Medical Corps.
No. 38045 Pte. J. Connolly, Royal Army Medical Corps.
No. 6234 Pte. (Lance-Cpl.) D. Cronin, Royal Army Medical Corps.
No. 61524 Serjt. C. P. Crosskey, Royal Army Medical Corps.
No. 42204 Pte. M. Dooley, Royal Army Medical Corps.
No. 68807 Pte. A. Douglas, Royal Army Medical Corps, attached Royal Field Artillery.
No. 2220 Pte. (Acting Cpl.) F. H. Down, Royal Army Medical Corps.
No. 49569 Cpl. (Acting Serjt.) W. Dunderdale, Royal Army Medical Corps.
No. 66354 Pte. H. W. Dutton, Royal Army Medical Corps.
No. 42597 Pte. T. Edwards, Royal Army Medical Corps.
No. 1145 Pte. W. Elliott, Royal Army Medical Corps.
No. 41733 Pte. (Lance-Cpl.) J. Evans, Royal Army Medical Corps.
No. 39908 Serjt. D. Forman, Royal Army Medical Corps.
No. 45865 Pte. A. Greenhill, Royal Army Medical Corps.
No. 38155 Pte. T. Hatton, Royal Army Medical Corps.
No. 121 Pte. L. Hawksworth, Royal Army Medical Corps.
No. 39429 Pte. R. A. Ives, Royal Army Medical Corps.
No. 74580 Pte. W. Keen, Royal Army Medical Corps.
No. 5310 Cpl. (Acting-Serjt.) A. G. Lever, Royal Army Medical Corps.
No. 68816 Pte. M. S. Lockhart, Royal Army Medical Corps.
No. 52777 Pte. A. C. E. Mellor, Royal Army Medical Corps.
No. 44108 Pte. F. J. Molloy, Royal Army Medical Corps.
No. 68449 Pte. J. W. Monkhouse, Royal Army Medical Corps.
No. 39451 Pte. A. Morris, Royal Army Medical Corps.
No. 59408 Serjt. A. C. Mowle, Royal Army Medical Corps.
No. 42739 Pte. A. Openshaw, Royal Army Medical Corps.
No. 37172 Pte. H. Parsons, Royal Army Medical Corps.
No. 1285 Serjt. A. W. Price, Royal Army Medical Corps.
No. 2192 Cpl. (Acting-Serjt.) T. J. Sevier, Royal Army Medical Corps.
No. 1992 Pte. J. S. Smith, Royal Army Medical Corps.
No. 7593 Pte. P. W. Steele, Royal Army Medical Corps.
No. 68875 Pte. (Acting Lance-Cpl.) H. Storry, Royal Army Medical Corps.
No. 46336 Pte. A. J. Taylor, Royal Army Medical Corps.
No. 53424 Cpl. (Acting-Serjt.) A. Todd, Royal Army Medical Corps.
No. 1872 Pte. R. Toy, Royal Army Medical Corps.
No. 11429 Pte. P. J. B. Webb, Royal Army Medical Corps, attached Machine Gun Corps.
No. 35893 Serjt. W. T. Williams, Royal Army Medical Corps.
No. 64018 Pte. (Acting Serjt.) G. Wilson, Royal Army Medical Corps.
No. 64905 Pte. M. Wilson, Royal Army Medical Corps.

The undermentioned Non-commission Officer has been awarded a Bar to his Military Medal :—

No. 903 Serjt. E. A. Brownhill, Royal Army Medical Corps.

(The awards of the Military Medal above mentioned were published in the *London Gazette*, dated December 9, 1916.)

March 2, 1917.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

Chancery of the Order,
St. John's Gate,
Clerkenwell, London, E.C.
February 28, 1917.

The King has been graciously pleased to sanction the following promotions in and appointments to the Order of the Hospital of St. John of Jerusalem in England.

As Esquire.

Lieut.-Col. George Bradshaw Stanistreet, M.B., Royal Army Medical Corps.

ROYAL ARMY MEDICAL CORPS.

Lieut-Col. George B. Stanistreet, C.M.G., to be an Assistant Director-General (temp.), March 1, 1917.

ARMY MEDICAL SERVICE.

Col. Alfred P. Blenkinsop, C.B., to be temporary Surgeon-General whilst employed as Director of Medical Services of an Expeditionary Force, March 1, 1917.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

SUMMARY OF THE PROCEEDINGS OF A QUARTERLY MEETING OF THE COMMITTEE WHICH WAS HELD AT THE ROYAL ARMY MEDICAL COLLEGE, JANUARY 23, 1917.

Present:

Dep.-Surg.-Gen. W. G. Don, Vice-President, in the Chair.
Surg.-Gen. W. S. M. Price, Vice-President.
Lieut.-Col. R. J. L. Fayle, D.S.O.
Lieut.-Col. J. More Reid.
Major G. S. Mansfield.
Major P. S. O'Reilly.

(1) Lieut.-Col. R. J. L. Fayle took his seat on the Committee under Rule XXVI.

(2) The Minutes of the Meeting of October 26, 1916, were read and confirmed.

(3) The question was considered as to whether application should be made to the National Debt Commissioners for withdrawal of the balance of the Society's deposit with them, amounting to about £104,000, in order that it might be invested in the new 5 per cent. War Loan.

The Secretary laid before the Committee the previous correspondence with the Commissioners, which took place on the issue of the 4½ per cent War Loan in 1915, on which occasion the Committee complied with the request of the Commissioners that only a small sum should be withdrawn. He also submitted a letter from the Consulting Actuary to the Society strongly urging that application for withdrawal should be made and stated that Sir James McGrigor fully concurred with the Actuary's opinion. The Secretary added that the Actuary's letter had been sent to the Trustees, all of whom entirely approved of the action recommended therein.

It was unanimously resolved that application be made for withdrawal of the whole sum, and the Secretary was authorized to take the necessary action.

(The money has since been paid and application made for War Stock.)

(4) It was resolved that £10,000 4½ per cent War Stock held by the Society be converted into 5 per cent War Stock, and also £1,000 5 per cent Exchequer Bonds.

(5) The investment in 5 per cent War Stock of a sum not exceeding £1,500 from cash balances was authorized.

(6) The following were admitted as married members of the Society: Capt. R. Davidson, Major A. H. McM. Mitchell, Capt. W. F. M. Loughnan, M.C. The first named being already an unmarried member does not pay the extra War charge of fifty guineas per annum.

(7) The Secretary reported that Major M. C. Beatty, a widower member, desired to continue his subscription at married rates for the benefit of his children.

(8) The deaths of the following annuitants were reported: Mrs. R. Gore, Mrs. H. S. Donald, Mrs. D. Domenichetti, Lady Horne.

(9) A certificate from the Actuary that the Securities held by the Society were Trustee Securities on December 31, 1916, was submitted.

(10) Payment of the Actuary's fee for the past year was sanctioned.

(11) Payment of the Secretary's salary and office allowance for the quarter ended December 31, 1916, was authorized.

The meeting closed with a vote of thanks to the Chair.

3, *Homefield Road*, *Wimbledon S.W.*

J. T. Clapham (*Captain*), *Secretary*.

ROYAL ARMY MEDICAL CORPS CENTRAL MESS FUND.

Summary of Proceedings of a Meeting of the Sub-Committee held at the Royal Army Medical College, on February 2, 1917.

Present:

Lieu.-Col. F. S. Irvine, D.S.O., in the Chair (Aldershot).
Capt. H. G. Gibson (London).
The Hon. Sec.

(1) The Minutes of the previous Meeting were read and confirmed.

(2) The Hon. Sec. reported that since the previous meeting an additional £100 for cash balances had been invested in 5 per cent. Exchequer Bonds, as then authorized; also that £200 had been invested in 6 per cent. Exchequer Bonds. These investments brought the total amount invested up to £700 in 5 per cent. Exchequer Bonds, and £200 in 6 per cent. Bonds. He added that Messrs. Holt and Co. had expressed their willingness to allow the customary balance kept with them to be reduced for the time being if the Committee desired to invest more of it in the new 5 per cent. War Loan.

It was resolved unanimously that the present holding of £700 in 5 per cent. Exchequer Bonds be converted into bonds of the 5 per cent. War Loan; but that the £200 in 6 per cent. Exchequer Bonds be not converted. Also that Messrs. Holt and Co. be authorized to apply for an additional fully paid allotment of £400 in bonds of the 5 per cent. War Loan, to be paid for out of current balances, as above mentioned.

(3) The Sub-committee then considered an application from the Committee of the Royal Army Medical Corps Mess, London, that the Central Fund would defray the cost (amounting to £42) of burglarly, fire and zeppelin insurances on the plate and trophies, &c., which were still in the mess; and also the annual charge (£41 4s. 6d.) for pension scheme for Brewer and Elliott. It was considered most necessary that the insurance of Corps property should be continued and that the pension scheme should not be allowed to lapse, and it was, therefore, resolved unanimously that the above mentioned sums be voted for these purposes, for the current year.

3, *Homefield Road*, *Wimbledon, S.W.*

J. T. Clapham (*Captain*), *Hon. Sec.*

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

We have received from the Secretary the following notice :—

UNIVERSITY OF LONDON, UNIVERSITY COLLEGE.

Session 1916-17.

A course of seven public lectures on "Psychology in Relation to the War" will be given on Wednesdays at 5.30 p.m., as follows:—

Second Term.

March 7 and 14: "The Psychology of the Unconscious and the War Neuroses," by E. W. Scripture, Ph.D., M.D., late Professor of Experimental Psychology at Yale University.

March 21:—"Repressed Instincts and War," by Ernest Jones, M.D., M.R.C.P.

Third Term.

May 9 and 16: "The Conflict of Motives," by Professor T. Percy Nunn, M.A., D.Sc., London Day Training College.

May 23: "Human Emotions in relation to War."

May 30: "Psychological Surveys and Educational Reconstruction," by C. Burt, M.A., Psychologist to the London County Council.

Admission free. No tickets required. Doors open at 5 p.m. Entrance, Gower Street.

WALTER W. SETON, M.A., D.Lit.,
Secretary.

BIRTH.

ROCHE.—On February 22, at 66, Herne Hill, London, the wife of Captain J. J. D. Roche, R.A.M.C., of a son.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of EXCERPTS *	Extra for Covers for Reprints: As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 8	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	5 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

All Applications for Advertisements to be made to—

G. STREET & CO., Ltd., 8, Serle Street, London, W.C.

The back outside cover is not available for advertisements.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Colonel M. H. Gordon; Captains S. R. Douglas, L. Colebrook; Lieutenant W. Parry Morgan, Esq.

The following publications have been received:—

British: Annals of Tropical Medicine and Parasitology, The Medical Press and Circular, The Medical Journal of Australia, St. Thomas's Hospital Gazette, Tropical Diseases Bulletin, The Medical Review, Bulletin of Entomological Research, The Lancet, The Journal of Tropical Medicine and Hygiene, The Practitioner.

Foreign: Le Caducée, Archives Médicales Belges, Bulletin de l'Institut Pasteur, The Journal of Infectious Diseases, The Military Surgeon, Giornale di Medicina Militare, Extrait des Annales de l'Institut Paris, Bulletin of the Johns Hopkins Hospital.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

THE HON. MANAGER,
"JOURNAL OF THE ROYAL ARMY MEDICAL CORPS,"
WAR OFFICE, WHITEHALL, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

April, 1917.

EXTRACTS FROM THE "LONDON GAZETTE."

War Office,
March 3, 1917.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officer to be Companion of the Distinguished Service Order in recognition of his gallantry and devotion to duty in the Field:—

Temp. Capt. Charles Owen Donovan, M.B., Royal Army Medical Corps, attached North Lancs Regiment.

For conspicuous gallantry and devotion to duty. He displayed courage of a very high order over a period of forty-eight hours in attending to a large number of wounded of his own and other units, in a shallow muddy trench, which was continually subjected to heavy fire. On another occasion he dressed several wounded officers in the open. He was severely wounded.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the Field:—

Temp. Capt. George Noel Braham, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He with four others worked continuously under intense fire, and succeeded in rescuing several wounded men from the advanced dressing station, which was untenable. He set a fine example of courage and determination throughout.

Temp. Capt. John Crawford, Royal Army Medical Corps

For conspicuous gallantry and devotion to duty. He took a party of stretcher-bearers to the position, and proceeded to attend to the wounded under heavy fire. He set a fine example of courage and coolness throughout.

Temp. Capt. John Ferguson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in tending to the wounded under the most intense hostile fire. Later, although himself wounded, he remained at his post until all the wounded men had been dressed.

Capt. Alaister Fraser Lee, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in attending to a very large number of wounded under continuous heavy shell fire. He was thrown down and wounded by the explosion of a shell, but continued to perform his duties in the most gallant manner.

Temp. Capt. William Douglas Reid, M.B., attached Manchester Regiment.

For conspicuous gallantry and devotion to duty. He displayed great courage and skill in tending the wounded under heavy fire. Later, although himself wounded, he continued to dress the wounded of all units. He has previously done fine work.

Capt. David Christopher Leslie Vey, Royal Army Medical Corps, Special Reserve, attached East Lancs Regiment.

For conspicuous gallantry and devotion to duty. He attended to the wounded in an open trench under very heavy fire. Later, he assisted to bring in many wounded men from the advanced trenches. He set a splendid example of courage and determination throughout.

Capt. Cyril James Berkeley Way, Royal Army Medical Corps, Special Reserve.

For conspicuous gallantry and devotion to duty. He repeatedly led his bearers through intense enemy barrages. He personally rescued several wounded men from shell holes under machine-gun fire.

AUSTRALIAN IMPERIAL FORCE.

Capt. Charles Kingsley Parkinson, Australian Army Medical Corps.

For conspicuous gallantry and devotion to duty. He brought several wounded stretcher-bearers into the dressing station under very heavy fire, thereby undoubtedly saving many lives. He set a splendid example of courage and determination throughout.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned man for acts of gallantry and devotion to duty in the Field:—

No. 242 Pte. H. J. Sipthorp, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He displayed great courage and determination in rescuing several wounded men from a blown-down shelter under very heavy fire. He set a splendid example throughout.

With reference to the announcement of the Distinguished Conduct Medals in the *London Gazette*, dated January 24, 1917, the following is an act of gallantry for which the decoration has been awarded:—

No. 76050 Pte. A. A. Devey, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although wounded, he remained at his post under very heavy fire until he was relieved. He set a fine example of courage and determination.

With reference to the announcement of the award of the Distinguished Conduct Medals in the Honours Supplement to the *London Gazette*, dated February 1, 1917, the following is an act of gallantry for which the decoration has been awarded:—

2nd Acting Serjt.-Major E. G. Gray, Royal Army Medical Corps.

For conspicuous devotion to duty. He carried out his work with marked ability and overcame great difficulties in obtaining supplies to feed our sick and to transport them to the advanced rest stations.

AWARD OF BAR TO MILITARY CROSS.

February 13, 1917.

For Temp. Capt. William Kenneth Mackenzie, M.C., M.B., Royal Army Medical Corps, *read* Temp. Capt. Kenneth William Mackenzie, M.C., M.B., Royal Army Medical Corps.

War Office,
March 9, 1917.

The following are among the Decorations and Medals awarded by the Allied Powers at various dates to the British Forces for distinguished services rendered during the course of the campaign:—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

DECORATIONS AND MEDALS CONFERRED BY H.M. THE KING OF SERBIA.

Order of St. Sava, 5th Class.

Capt. Ryder Percival Nash, Royal Army Medical Corps.

Distinguished Service Medal.

Temp. Capt. Rainald Heaton, Royal Army Medical Corps.

Gold Medal.

No. 74089 Serjt. James Frederick Ambery, Royal Army Medical Corps.

Silver Medal.

No. 75543 Acting Corpl. Ernest Hatchwell, Royal Army Medical Corps.

July 6, 1916.

Order of St. Sava, 3rd Class.

Major Herbert St. Maur Carter, D.S.O., M.B., Royal Army Medical Corps.

DECORATIONS AND MEDALS CONFERRED BY H.M. THE KING OF MONTENEGRO.

October 31, 1916.

Silver Medal for Bravery.

Temp. Capt. Donald Olson Riddell, D.S.O., M.B., Royal Army Medical Corps.

DECORATIONS CONFERRED BY H.H. THE SULTAN OF EGYPT.

Order of the Nile, *3rd Class.*

Colonel James Fallon, Army Medical Service.

Note.—The above-mentioned Decorations and Medals have not been received by the War Office for distribution.

Officers, Non-commissioned Officers, or men who have not yet received the decorations of which the award appears in this *Gazette* should communicate with the Military Secretary, Foreign Decorations Section, 14, Albemarle Street, London, W.

March 17, 1917.

AWARDED DISTINGUISHED SERVICE ORDER.

Capt. Allan Watson, M.B., Royal Army Medical Corps.

AWARDED THE MILITARY CROSS.

Temp.-Lieut. A. Yeshwant Dabholkar, Indian Medical Service.
Temp. Capt. John Low, M.B., Royal Army Medical Corps.
Temp. Capt. Charles O'Brien, M.B., Royal Army Medical Corps.

War Office,
March 26, 1917.

His Majesty the King has been graciously pleased to award a Bar to the Military Cross to the undermentioned Officer:—

Temp. Capt. Archibald Stirling Kennedy Anderson, M.B., M.C., Royal Army Medical Corps, attached R.N. Field Ambulance.

For conspicuous gallantry and devotion to duty. He rendered most valuable services while in command of a bearer subdivision in assisting to collect wounded from a forward area under very heavy fire.

(M.C. gazetted August 25, 1916.)

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the field:—

Temp. Lieut. Herbert John Davidson, M.B., Royal Army Medical Corps, attached R.N. Field Ambulance.

For conspicuous gallantry and devotion to duty. He tended the wounded in a forward area under very heavy fire. He set a splendid example to all ranks.

Capt. Robert Andrew Kerr, M.B., Royal Army Medical Corps, attached Royal Warwickshire Regiment.

For conspicuous gallantry and devotion to duty. He succeeded in rescuing his three bearers, who were entombed when the aid post was blown in. He constantly visited the most dangerous parts of the line in order to attend the wounded.

Temp. Lieut. Allan George Reid, Royal Army Medical Corps, attached R.N. Field Ambulance.

For conspicuous gallantry and devotion to duty. He tended the wounded under very heavy fire, and worked continuously for thirty-six hours in command of a bearer subdivision which was operating in a forward area.

AUSTRALIAN IMPERIAL FORCE.

Capt. Norman Craig Shierlaw, Australian Army Medical Corps, R.M.O., Australian Infantry.

For conspicuous gallantry and devotion to duty. He continually attended to the wounded for two days and nights under very heavy fire. He has on many previous occasions done fine work.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned man:—

No. 69522 Pte. R. Jones, Royal Army Medical Corps, attached R.F.A.

For conspicuous gallantry and devotion to duty. He repeatedly tended the wounded under very heavy fire. He has at all times set a fine example of courage and determination.

His Majesty the King has been graciously pleased to approve of the award of a Bar to the Military Medal to the undermentioned man :—

No. 41539 Pte. (Acting Cpl.) J. Fraser, Royal Army Medical Corps.
(M.M. gazetted June 3, 1916.)

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned men :—

No. 88017 Pte. W. Harris, Royal Army Medical Corps.
No. 2546 Pte. B. H. Hatcher, Royal Army Medical Corps.
No. 1836 Pte. A. Hemming, Royal Army Medical Corps.
No. 53512 Pte. W. H. Laidlaw, Royal Army Medical Corps.
No. 197522 Cpl. W. Mason, attached Royal Engineers (late Royal Army Medical Corps).
No. 43045 Pte. J. McCullock, Royal Army Medical Corps.
No. 59556 Pte. W. Moir, Royal Army Medical Corps.
No. 63453 Pte. (Acting Corporal) A. E. Phillips, Royal Army Medical Corps.
No. 523 Pte. A. C. Staniland, Royal Army Medical Corps.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

The King has been graciously pleased to sanction the following promotion in and appointment to the Order of the Hospital of St. John of Jerusalem in England :—

As Knight of Grace.

Col. George Henry Barefoot, C.B., C.M.G., L.R.C.P.Ed., Army Medical Service.

War Office,
March 30, 1917.

ADDITIONAL MENTION IN DISPATCHES.

The following is added to the list of names brought to the notice of the Secretary of State for War for distinguished services rendered in connexion with the War (published in the Supplement to the *London Gazette*, No. 29919, dated January 25, 1917).

Temp. Capt. E. P. Satchell, M.B., Royal Army Medical Corps.

CORRIGENDUM.

Supplement to the *London Gazette*, dated January 25, 1917 (No. 29919). *For* Major W. I. de Courcy Wheeler, Royal Army Medical Corps, *read* Hon. Major W. I. de Courcy Wheeler, M.D., F.R.C.S.I., Royal Army Medical Corps.

ARMY MEDICAL SERVICE.

Lieut.-Col. George A. Moore, C.M.G., M.D., to be Temp. Col. whilst employed as Assistant Director of Medical Services of a Division, dated January 15, 1917.

ROYAL ARMY MEDICAL CORPS.

The date on which Major H. W. Long, M.B., relinquished the acting rank of Lieut.-Col. is November 21, 1916, and not as in the *Gazette* of January 22, 1917.

Major John C. B. Statham, C.M.G., to be Temp. Lieut.-Col. whilst employed as Director of Medical Services, from December 25, 1914, to February 28, 1915.

The undermentioned to retain the acting rank of Lieut.-Col. :—

Dated January 6, 1917.—Capt. Thomas E. Eves, M.B., whilst commanding a Field Ambulance.

Dated January 14, 1917.—Major Dermot O. Hyde, D.S.O., M.B., whilst commanding a Casualty Clearing Station.

Dated January 15, 1917.—Major Bernard B. Burke, D.S.O., whilst commanding a Stationary Hospital.

The undermentioned Majors relinquish the acting rank of Lieut.-Col. on reposting:

Dated February 17, 1917.—John Fairbairn, M.B.

Dated March 1, 1917.—Rowland P. Lewis.

Dated March 3, 1917.—Major John Powell, M.B.

Maj. John W. West, M.B., to be Acting Lieut.-Col. whilst commanding a General Hospital, from February 3 to 14, 1917.

The undermentioned to be Acting Lieut.-Cols., whilst commanding a Field Ambulance, dated January 28, 1917 :—

Capt. Thomas H. Scott, M.C., M.B.

Temp. Capt. Francis F. Muecke, M.B., F.R.C.S.

Dated January 28, 1917.—Major William Riach, C.M.G., M.D., to be Acting Lieut.-Col. whilst commanding a Casualty Clearing Station.

Dated January 29, 1917.—Temp. Capt. Lawrence D. Shaw, M.B.

Dated January 30, 1917.—Temp. Capt. Ralph E. Drake-Brockman.

Dated February 20, 1917.—Capt. B. Biggar, M.B., is seconded for service with the Egyptian Army.

The undermentioned Captains to be Acting Majors whilst commanding a Field Ambulance:—

Dated August 22, 1916.—Philip G. M. Elvery, M.C.; George F. Rudkin, D.S.O.; Charles L. Franklin, M.B.; Arthur D. O'Carroll, M.B.; Gerald H. Stevenson, M.B.; Percy S. Tomlinson; Benjamin Johnson, M.B.; Temp. Capt. Christopher V. Bulstrode.

Dated November 15, 1916.—Edward M. Middleton.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

NOTICE OF THE ANNUAL GENERAL MEETING, 1917.

THE Annual General Meeting of subscribers to this Society will be held in the Library of the Royal Army Medical College, Grosvenor Road, S.W., at 3 p.m., on Monday, June 11, 1917.

The Director-General will preside.

It is hoped that all subscribers will freely express their views on any point connected with the Society. Those subscribers who may wish for information on any special point are requested to communicate with the Secretary, so that the necessary information may be furnished in response to any question asked.

F. W. H. DAVIE HARRIS,
Lieutenant-Colonel,
Secretary.

124, *Victoria Street, S.W.*

ROYAL ARMY MEDICAL CORPS FUND.

NOTICE OF THE ANNUAL GENERAL MEETING, 1917.

THE Annual General Meeting of subscribers to this Fund will be held in the Library of the Royal Army Medical College, Grosvenor Road, S.W., at 2.30 p.m., on Monday, June 11, 1917.

It is hoped that all subscribers will freely express their views on any point connected with the Fund. Those officers who may wish for information on any special point are requested to communicate with the Secretary, so that the necessary information may be furnished in response to any question asked.

F. W. H. DAVIE HARRIS,
Lieutenant-Colonel,
Secretary.

124, *Victoria Street, S.W.*

BIRTH.

HARDING.—On March 26, at 26, Claremont Avenue, Blackpool, to Queenie (née Randall) wife of Major H. Harding, R.A.M.C., a son.

MARRIAGE.

BUCKLEY—BRINDEJONT.—On February 17, at the Church of St. Ferdinand des Ternes, Paris, Capt. Leonard Buckley, R.A.M.C., sixth and youngest son of William Buckley, J.P., Blundellsands, to Suzanne, only daughter of Prosper Brindejont, of Paris.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints: As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
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	8	0 5 0	0 2 3				
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5	4 10	1 6	4 4	0 11
	8	0 6 0	0 2 9				
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10	5 0	2 1	4 10	1 2
	8	0 7 6	0 3 6				
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1	7 10	3 11	6 7	2 5
	8	0 10 0	0 4 10				
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5	10 10	7 6	9 0	4 10
	8	0 15 0	0 6 7				
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W.

Communications have been received from Majors G. Sichel, R. W. D. Leslie, F. B. Lawton, H. French; Captains J. R. McCurdie, W. F. M. Loughnan, T. O. Thompson, J. J. M. Shaw, G. A. Child, R. P. Garrow, E. M. Jenkins, A. Gregor, A. H. Caulfeild, C. H. Treadgold, H. M. Woodcock, Esq.

The following publications have been received:—

British: The Hospital, The Medical Press and Circular, Public Health, The Indian Medical Gazette, The Journal of State Medicine, Pasteur Institute of India, The Journal of Tropical Medicine and Hygiene, The Army Service Corps Journal, Proceedings of the Royal Society of Medicine, St. Thomas's Hospital Reports, Journal of the Royal United Service Institution, The British Medical Journal, Tropical Diseases Bulletin, The Practitioner, The Medical Journal of Australia, St. Bartholomew's Hospital Journal, Guy's Hospital Gazette, The Medical Journal of South Africa, The Royal Engineers' Journal, St. Thomas's Hospital Gazette, Tropical Veterinary Bulletin.

Foreign: Archives Médicales Belges, Norsk Tidsskrift for Militaermedicin, United States Department of Agriculture, Bulletin de l'Institut Pasteur, Le Caducée, Archives de Médecine et Pharmacie Navales, Bollettino dell'Istituto Sieroterapico Milanese, L'Ospedale Maggiore, Rivista Marittima, Archives de Médecine et de Pharmacie Militaires, Bulletin of the Johns Hopkins Hospital, The Military Surgeon, Report of the Surgeon General United States Army, Annali di Medicina Navale e Coloniale, The American Journal of Syphilis, Office International d'Hygiène Publique, The Journal of Infectious Diseases, Archives de Médecine et Pharmacie Navales, Bulletin de la Societé de Pathologie Exotique, Revue de Chimiothérapie et de Médecine Générale.

MANAGER'S NOTICES.

The Journal of the Royal Army Medical Corps is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager "Journal of the Royal Army Medical Corps," War Office, Whitehall, London S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL
OF THE
ROYAL ARMY MEDICAL CORPS.

Corps News.

May, 1917.

EXTRACTS FROM THE "LONDON GAZETTE."

War Office,
February 24, 1917.

The names of the undermentioned have been brought to the notice of the Secretary of State for War for valuable services rendered in connexion with the War:—

Temp. Capt. A. Abrahams, M.D., Royal Army Medical Corps.
Col. G. G. Adams, Army Medical Service.
Surg.-Col. J. Aikman, M.D., Principal Medical Officer, Royal Guernsey Militia.
Major J. A. Anderson, Royal Army Medical Corps.
Lieut.-Col. J. B. Anderson, Royal Army Medical Corps.
Major R. Y. Anderson, Royal Army Medical Corps.
Capt. E. G. Annis, Royal Army Medical Corps.
Temp. Col. J. Atkins, C.M.G., M.B., F.R.C.S., Army Medical Service.
Lieut.-Col. C. Averill, Royal Army Medical Corps.
Major E. U. Bartholomew, Royal Army Medical Corps.
Lieut.-Col. H. L. Battersby, retired pay, late Royal Army Medical Corps.
Capt. A. Baxter, Royal Army Medical Corps.
Qmr. and Hon. Major J. H. W. Beach, Royal Army Medical Corps.
Col. J. M. Beamish, M.D., Army Medical Service.
Surg.-Gen. W. G. A. Bedford, C.B., C.M.G., Army Medical Service.
Capt. J. A. Bennett, Royal Army Medical Corps.
Surg.-Lieut.-Col. P. B. Bentliff, Medical Corps, Jersey Militia.
Major G. Biggs, Royal Army Medical Corps.
Col. de B. Birch, C.B., V.D., Army Medical Service.
Surg.-Gen. W. G. Birrell, Army Medical Service.
Lieut.-Col. R. A. Bolam, Royal Army Medical Corps.
Hon. Col. C. J. Bond, F.R.C.S., Army Medical Service.
Lieut.-Col. R. P. Bond, Royal Army Medical Corps.
Brevet-Lieut.-Col. J. S. Bostock, M.B., Royal Army Medical Corps.
Surg.-Capt. R. A. Bostock, retired, Reserve of Officers, Scots Guards.
Major C. Bramhall, Royal Army Medical Corps.
Capt. F. W. Broderick, Royal Army Medical Corps.
Lieut.-Col. H. H. Brown, M.B., Royal Army Medical Corps.
Lieut.-Col. J. B. W. Buchanan, retired, late Royal Army Medical Corps.
Temp. Capt. R. Buchanan, Royal Army Medical Corps.
Col. W. H. Bull, V.D., Army Medical Service.
Lieut.-Col. (Temp. Col.) P. C. Burgess, Royal Army Medical Corps.
Col. E. A. Burnside, Army Medical Service.
Lieut.-Col. J. P. Bush, C.M.G., Royal Army Medical Corps.

Col. E. Butt, Army Medical Service.
Lieut.-Col. R. Caldwell, F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. A. Callam, Royal Army Medical Corps.
Lieut.-Col. E. M. Callender, Royal Army Medical Corps.
Temp. Major A. H. Carter, Royal Army Medical Corps.
Temp. Major (Lieut.-Col., Territorial Force Reserve) T. M. Carter, Royal Army Medical Corps.
Temp. Capt. E. P. G. Causton, Royal Army Medical Corps.
Major A. J. Chambers, retired, Royal Army Medical Corps.
Lieut.-Col. H. Charlesworth, C.M.G., retired, Royal Army Medical Corps.
Lieut.-Col. C. P. Childe, F.R.C.S., Royal Army Medical Corps.
Qmr. and Hon. Major A. Clapshaw, Royal Army Medical Corps.
Col. W. Coates, C.B., Army Medical Service.
Lieut.-Col. A. Connell, F.R.C.S., Royal Army Medical Corps.
Qmr. and Hon. Major H. Copping, Royal Army Medical Corps.
Lieut.-Col. M. P. Corkery, Royal Army Medical Corps.
Capt. W. B. Cosens, Royal Army Medical Corps.
Temp. Major E. G. Coward, M.B., Royal Army Medical Corps.
Major J. J. Cox, Royal Army Medical Corps.
Col. A. E. J. Croly, Army Medical Service.
Surg.-Lieut.-Col. Sir W. R. Crooke-Lawless, Knt., C.I.E., M.D., Reserve of Officers, Coldstream Guards.
Surg.-Gen. J. C. Culling, Army Medical Service.
Qmr. and Hon. Lieut. W. Culver, Royal Army Medical Corps.
Temp. Capt. C. C. de B. Daly, Royal Army Medical Corps.
Temp. Capt. F. J. P. Daly, Royal Army Medical Corps.
Col. T. F. Dewar, Army Medical Service.
Lieut.-Col. A. Dodd, Royal Army Medical Corps.
Capt. C. M. Drew, Royal Army Medical Corps.
Major C. W. Duggan, Royal Army Medical Corps.
Qmr. and Hon. Capt. W. Duncan, Royal Army Medical Corps.
Temp. Capt. J. G. Duncanson, Royal Army Medical Corps.
Capt. (Temp. Lieut.-Col.) C. W. Eames, Royal Army Medical Corps.
Temp. Lieut.-Col. F. W. Ellis, M.D., F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. D. E. Evans, Royal Army Medical Corps.
Temp. Capt. J. Ewing, Royal Army Medical Corps.
Lieut.-Col. N. Faichnie, Royal Army Medical Corps.
Major M. W. Falkner, Royal Army Medical Corps.
Capt. (Temp. Major) A. C. Farquharson, M.D., Royal Army Medical Corps.
Col. C. E. Faunce, Army Medical Service.
Surg.-Gen. W. J. Fawcett, C. B., retired pay.
Lieut.-Col. E. H. Fenwick, Royal Army Medical Corps.
Major J. C. Ferness, Royal Army Medical Corps, Special Reserves.
Temp. Capt. W. T. Finlayson, Royal Army Medical Corps.
Temp. Major S. Fleming, Royal Army Medical Corps.
Surg.-Gen. R. W. Ford, C.B., D.S.O., Royal Army Medical Corps.
Col. R. H. Forman, Army Medical Service.
Temp. Capt. E. R. Fothergill, Royal Army Medical Corps.
Major C. E. P. Fowler, Royal Army Medical Corps.
Lieut.-Col. D. F. Franklin, F.R.C.S., retired pay, late Royal Army Medical Corps.
Lieut.-Col. R. S. R. Fuhr, D.S.O., Royal Army Medical Corps.
Major W. M. Gabriel, Royal Army Medical Corps.
Surg.-Gen. Sir T. J. Gallwey, K.C.M.G., C.B.
Lieut.-Col. A. B. Gemmel, Royal Army Medical Corps.
Temp. Lieut.-Col. T. H. Gibbon, Royal Army Medical Corps.
Col. P. B. Giles, C.B., F.R.C.S., Army Medical Service.
Temp. Capt. H. D. Gillies, Royal Army Medical Corps.
Temp. Major D. Gillespie, M.D., Royal Army Medical Corps.
Temp. Major A. G. P. Gipps, Royal Army Medical Corps.
Qmr. and Hon. Major B. Goater, Royal Army Medical Corps.
Col. G. T. Goggin, retired pay.
Temp. Qmr. and Hon. Lieut. W. Goodly, Royal Army Medical Corps.
Col. St.J. C. Gore, C.B., Army Medical Service.
Lieut.-Col. T. Gowans, M.B., Royal Army Medical Corps.

Major E. Gray, Royal Army Medical Corps.
Col. J. Griffiths, Army Medical Service.
Lieut.-Col. P. B. Haig, M.B., Royal Army Medical Corps.
Qmr. and Hon. Major F. W. Hall, Royal Army Medical Corps.
Lieut.-Col. R. H. Hall, Royal Army Medical Corps.
Temp. Major J. Hall-Edwards, Royal Army Medical Corps.
Lieut.-Col. T. W. O'H. Hamilton, C.M.G., Royal Army Medical Corps.
Lieut.-Col. L. K. Harrison, M.B., Royal Army Medical Corps.
Lieut.-Col. W. F. Haslam, Royal Army Medical Corps.
Surg.-Gen. H. G. Hathaway, C.B., Army Medical Service.
Lieut.-Col. H. P. Hawkins, Royal Army Medical Corps.
Lieut.-Col. T. H. Haydon, Royal Army Medical Corps.
Major R. W. W. Henry, M.D., Royal Army Medical Corps.
Surg.-Lieut.-Col. and Hon. Surg.-Col. D. Hepburn, M.D., Royal Army Medical Corps (Territorial Force).
Temp. Capt. F. Hernaman-Johnson, Royal Army Medical Corps.
Qmr. and Hon. Lieut. W. Hicks, Royal Army Medical Corps.
Brevet-Col. W. Hind, M.D., F.R.C.S., Army Medical Service.
Capt. W. M. Holmes, M.B., Royal Army Medical Corps.
Col. S. S. Hoyland, Army Medical Service.
Major J. K. Jamieson, M.B., Royal Army Medical Corps.
Qmr. and Hon. Lieut. E. Janes, Royal Army Medical Corps.
Surg.-Gen. F. J. Jencken, M.B., Army Medical Service.
Col. R. Jennings, Army Medical Service.
Lieut.-Col. A. G. Kay (retired pay), late Royal Army Medical Corps.
Lieut.-Col. J. R. Kaye, Royal Army Medical Corps.
Lieut.-Col. J. Kearney, M.D. (retired pay), late Royal Army Medical Corps.
Col. W. Kinnear, Army Medical Service.
Major F. W. Lamballe, M.B., Royal Army Medical Corps.
Lieut.-Col. F. S. Lambert, Royal Army Medical Corps.
Lieut.-Col. R. V. Lane (retired pay), late Royal Army Medical Corps.
Major H. A. Leebody, Royal Army Medical Corps.
Lieut.-Col. F. S. Le Quesne, V.C., Royal Army Medical Corps.
Capt. (Temp. Lieut.-Col.) W. Lister, Royal Army Medical Corps.
Lieut.-Col. H. Littlewood, Royal Army Medical Corps.
Col. T. J. R. Lucas, C.B., Army Medical Service.
Capt. A. McGillivray, Royal Army Medical Corps.
Lieut.-Col. C. W. Magrath, Royal Army Medical Corps.
Capt. H. J. McGrigor, Reserve of Officers, Royal Army Medical Corps.
Temp. Capt. D. J. McLeish, Royal Army Medical Corps.
Temp. Capt. J. M. MacMillan, Royal Army Medical Corps.
Lieut.-Col. J. Maconachie, F.R.C.S. (retired pay), late Royal Army Medical Corps.
Lieut.-Col. C. W. S. Magrath, Royal Army Medical Corps.
Temp. Major N. S. Manning, F.R.C.S.I., Royal Army Medical Corps.
Temp. Capt. H. T. Mant, Royal Army Medical Corps.
Lieut.-Col. F. Marsh, F.R.C.S., Royal Army Medical Corps.
Temp. Lieut.-Col. W. L. W. Marshall, Royal Army Medical Corps.
Qmr. and Hon. Lieut. Mathews, Royal Army Medical Corps.
Lieut.-Col. W. J. Maurice, Royal Army Medical Corps.
Col. W. A. May, C.B., Army Medical Service.
Lieut.-Col. E. F. Maynard, Royal Army Medical Corps.
Temp. Lieut.-Col. G. E. Miles, Royal Army Medical Corps.
Temp. Hon. Major C. H. Miller, Royal Army Medical Corps.
Major J. D. Moir, Royal Army Medical Corps (Reserve of Officers).
Lieut.-Col. R. R. H. Moore, Royal Army Medical Corps.
Lieut.-Col. A. E. Morris, Royal Army Medical Corps.
Temp. Lieut.-Col. R. J. Morris, M.D., Royal Army Medical Corps.
Lieut.-Col. R. E. R. Morse, Royal Army Medical Corps (retired list).
Temp. Lieut.-Col. S. Mort, Royal Army Medical Corps.
Temp. Capt. G. Muir, M.B., Royal Army Medical Corps.
Lieut.-Col. Sir F. S. Murphy, Royal Army Medical Corps.
Major E. H. Myddelton-Gavey, Royal Army Medical Corps.
Major E. H. Myles, M.B. (retired pay), late Royal Army Medical Corps.
Lieut.-Col. F. P. Nichols, M.B., Royal Army Medical Corps.

Lieut.-Col. J. E. Nicholson (retired pay), late Royal Army Medical Corps.
Lieut.-Col. O'Connell, M.D., Royal Army Medical Corps (retired).
Lieut.-Col. J. Oldfield, Royal Army Medical Corps.
Col. C. P. Oliver, Army Medical Service.
Major P. S. O'Reilly, Royal Army Medical Corps.
Lieut.-Col. D. C. L. Orton, Royal Army Medical Corps.
Qmr. and Hon. Capt. G. H. Painton, Royal Army Medical Corps.
Temp. Capt. R. R. K. Paton, M.B., Royal Army Medical Corps.
Major D. W. Patterson, M.B., Royal Army Medical Corps.
Capt. H. J. Pechell, Royal Army Medical Corps.
Major D. J. Penney, Royal Army Medical Corps.
Col. A. Peterkin (retired pay), Army Medical Service.
Lieut.-Col. and Brevet-Col. E. M. Pilcher, D.S.O., M.B., F.R.C.S., Royal Army Medical Corps.
Major W. R. Pirie, M.D., Royal Army Medical Corps.
Lieut.-Col. P. J. Probyn, D.S.O., M.B., Royal Army Medical Corps.
Col. J. R. I. Raywood, Army Medical Service.
Temp. Major H. J. Roberts, M.D., F.R.C.S., Royal Army Medical Corps.
Qmr. and Hon. Lieut. C. J. Rogers, Royal Army Medical Corps.
Lieut.-Col. (Hon. Surg.-Col., Temp. Col.) W. M. Roocroft, Royal Army Medical Corps.
Col. A. F. Russell, C.M.G., M.B. (retired pay), Army Medical Service.
Col. J. V. W. Rutherford, M.B., V.D., Army Medical Service, Territorial Force Reserve.
Capt. M. W. Ruthven, Royal Army Medical Corps (Special Reserve).
Lieut.-Col. J. V. Salvage, M.D. (retired pay), Royal Army Medical Corps.
Temp. Capt. H. R. Sedgwick, Royal Army Medical Corps.
Temp. Major H. J. Shirley, M.D., F.R.C.S., Royal Army Medical Corps.
Major E. W. Siberry, Royal Army Medical Corps.
Col. R. J. S. Simpson, Royal Army Medical Corps.
Major W. V. Sinclair, Royal Army Medical Corps.
Temp. Major G. H. Spencer, Royal Army Medical Corps.
Lieut.-Col. W. H. Steele, Royal Army Medical Corps (ret. pay).
Temp. Capt. C. R. Stewart, M.B., Royal Army Medical Corps.
Temp. Capt. J. S. Stewart, Royal Army Medical Corps.
Major H. Stott, Royal Army Medical Corps.
Qmr. and Hon. Lieut. D. Stout, Royal Army Medical Corps.
Lieut.-Col. L. W. Swabey, Royal Army Medical Corps.
Temp. Major R. H. J. Swan, M.B., F.R.C.S., Royal Army Medical Corps.
Major and Brevet Lieut.-Col. C. R. Sylvester-Bradley, Royal Army Medical Corps
Lieut.-Col. C. J. W. Tatham, Royal Army Medical Corps (ret.).
Temp. Capt. J. Taylor, Royal Army Medical Corps.
Lieut.-Col. C. W. Thiele, Royal Army Medical Corps (ret. pay).
Temp. Capt. D. J. Thomas, M.D., Royal Army Medical Corps.
Lieut.-Col. J. Tidbury, Royal Army Medical Corps.
Qmr. and Hon. Lieut. A. G. Tod, Royal Army Medical Corps.
Col. C. Todd, Army Medical Service.
Temp. Col. H. H. Tooth, Royal Army Medical Corps.
Temp. Capt. A. Trower, Royal Army Medical Corps.
Capt. J. E. Turle, Royal Army Medical Corps.
Lieut.-Col. W. Turner (ret. pay), Royal Army Medical Corps.
Temp. Lieut.-Col. W. J. N. Vincent, Royal Army Medical Corps.
Temp. Capt. T. G. Wakeling, Royal Army Medical Corps.
Major D. Wallace, C.M.G., Royal Army Medical Corps.
Major G. W. Watson, M.D., F.R.C.P., Royal Army Medical Corps.
Lieut.-Col. H. W. Webber, Royal Army Medical Corps.
Temp. Capt. H. H. Weekes, Royal Army Medical Corps.
Lieut.-Col. F. H. Westmacott, F.R.C.S.
Lieut.-Col. S. White, Royal Army Medical Corps.
Lieut.-Col. C. W. H. Whitestone, Royal Army Medical Corps.
Lieut-Col. M. J. Whitty, Royal Army Medical Corps (ret. pay).
Temp. Capt. J. R. Williamson, Royal Army Medical Corps.
Major A. Wilson, Royal Army Medical Corps.
Lieut.-Col. G. Wilson (ret. pay), R.A.M.C.
Qmr. and Hon. Capt. J. Wilson, Royal Army Medical Corps.

Lieut.-Col. T. B. Winter, Royal Army Medical Corps.
Capt. C. W. Wirgman, Royal Army Medical Corps.
Temp. Capt. W. H. Wishart, Royal Army Medical Corps.
Capt. (Temp. Major) T. B. Wolstenholme, M.B., Royal Army Medical Corps.
Lieut.-Col. G. S. Woodhead, Royal Army Medical Corps.
Temp. Capt. L. D. Woods, Royal Army Medical Corps.
Temp. Lieut.-Col. A. S. Woodwark, Royal Army Medical Corps.
Temp. Lieut.-Col. J. F. Woodyatt, Royal Army Medical Corps.
Temp. Lieut.-Col. W. M. D. Wrangham, Royal Army Medical Corps.
No. 27283 Pte. R. Alston, Royal Army Medical Corps.
No. 19202 Acting Serjt. J. B. Baidon, Royal Army Medical Corps.
No. 12809 Acting Serjt. E. Barber, Royal Army Medical Corps.
No. 104694 Acting Lance-Cpl. E. H. Barker, Royal Army Medical Corps.
No. 25673 Cpl. T. Barker, Royal Army Medical Corps.
No. 23099 Acting Serjt. T. V. Barrow, Royal Army Medical Corps.
No. 9632 Serjt.-Major J. Baxter, Royal Army Medical Corps.
No. 43910 Serjt. P. R. Bemrose, Royal Army Medical Corps.
No. 8487 Qmr.-Serjt. H. Bicknell, Royal Army Medical Corps.
No. 32015 Acting Qmr.-Serjt. H. Boasten, Royal Army Medical Corps.
No. 2057 Pte. H. Bobby, Royal Army Medical Corps.
No. 809 Lance-Cpl. F. Brayley, Royal Army Medical Corps.
No. 9711 Staff-Serjt. W. Brooklesby, Royal Army Medical Corps.
No. 16462 Serjt. A. A. Bushman, Royal Army Medical Corps.
No. 27336 Staff-Serjt. A. G. Carpenter, Royal Army Medical Corps.
No. 18917 Staff-Serjt. H. Chadwick, Royal Army Medical Corps.
No. 19464 Serjt. C. Chamberlain, Royal Army Medical Corps.
No. 12461 Qmr.-Serjt. P. F. Cook, Royal Army Medical Corps.
No. 2254 Serjt. A. R. Crane, Royal Army Medical Corps.
No. 8770 Acting Serjt.-Major J. Crossman, Royal Army Medical Corps.
No. 1752 Cpl. A. J. Davey, Royal Army Medical Corps.
No. 400 Serjt.-Major H. B. Dotterill, Royal Army Medical Corps.
No. 27722 Serjt. J. Eaves, Royal Army Medical Corps.
No. 27293 Qmr.-Serjt. C. E. Evans, Royal Army Medical Corps.
No. 12428 Acting Serjt.-Major F. J. Fergusson, Royal Army Medical Corps.
No. 401 Qmr.-Serjt. J. Flanagan, Royal Army Medical Corps.
No. 22136 Serjt. H. E. Foster, Royal Army Medical Corps.
No. 1316 Staff-Serjt. S. R. B. Franks, Royal Army Medical Corps.
No. 12522 Serjt.-Major S. Gallie, Royal Army Medical Corps.
No. 11 Serjt.-Major R. Gilmour, Royal Army Medical Corps.
No. 12626 Qmr.-Serjt. H. Heald, Royal Army Medical Corps.
No. 16289 Staff-Serjt. C. G. Hearn, Royal Army Medical Corps.
No. 12616 Serjt. E. Homsley, Royal Army Medical Corps.
No. 73664 Acting-Serjt. J. W. Heywood, Royal Army Medical Corps.
No. 31764 Acting-Serjt.-Major J. E. Hogan, Royal Army Medical Corps.
No. 11270 Serjt.-Major B. Holmes, Royal Army Medical Corps.
No. 9350 Serjt.-Major A. Horne, Royal Army Medical Corps.
No. 14602 Serjt.-Major J. Hughes, Royal Army Medical Corps.
No. 10183 Qmr.-Serjt. W. J. James, Royal Army Medical Corps.
No. 9727 Staff-Serjt. G. H. F. Kemp, Royal Army Medical Corps.
No. 102971 Serjt.-Major R. Knight, Royal Army Medical Corps.
No. 26793 Serjt. H. Langmaide, Royal Army Medical Corps.
No. 100834 Pte. A. Lock, Royal Army Medical Corps.
No. 1005 Staff-Serjt. C. H. J. Locke, Royal Army Medical Corps.
No. 2027 Cpl. R. McCartney, Royal Army Medical Corps.
No. 19685 Acting-Serjt. P. McGinnis, Royal Army Medical Corps.
No. 29699 Acting-Staff-Serjt. F. H. Moore, Royal Army Medical Corps.
No. 17726 Staff-Serjt. (Acting Serjt.-Major) C. P. Murphy, Royal Army Medical Corps.
No. 9975 Staff-Serjt. J. E. Partridge, Royal Army Medical Corps.
No. 18018 Acting-Serjt. F. G. Phipps, Royal Army Medical Corps.
No. 19780 Acting-Serjt. T. H. Pimlott, Royal Army Medical Corps.
No. 26882 Staff-Serjt. C. Pitkin, Royal Army Medical Corps.
No. 6671 Acting-Serjt. J. H. Plumridge, Royal Army Medical Corps.
No. 24461 Pte. J. R. Rudman, Royal Army Medical Corps.

No. 25327 Serjt.-Major W. Rushton, Royal Army Medical Corps.
No. 105312 Serjt. A. T. Sampson, Royal Army Medical Corps.
No. 1523 Staff-Serjt. A. F. Senior, Royal Army Medical Corps.
No. 42824 Pte. A. E. Sim, Royal Army Medical Corps.
No. 11789 Staff-Serjt. (Acting-Serjt.-Major) W. Skinner, Royal Army Medical Corps.
No. 23879 Serjt.-Major H. F. Stacey, Royal Army Medical Corps.
No. 26020 Serjt.-Major A. Stead, Royal Army Medical Corps.
No. 1694 Acting-Serjt.-Major G. L. Stiles, Royal Army Medical Corps.
No. 19023 Acting-Serjt.-Major Tarber, Royal Army Medical Corps.
No. 26464 Serjt. E. J. Taylor, Royal Army Medical Corps.
No. 29578 Cpl. G. H. Trebble, Royal Army Medical Corps.
No. 29571 Acting-Serjt. Trebble, Royal Army Medical Corps.
No. 12265 Acting-Serjt.-Major A. G. Turpin, Royal Army Medical Corps.
No. 14356 Staff-Serjt. W. L. Vyse, Royal Army Medical Corps.
No. 53 Staff-Serjt. J. C. Walker, Royal Army Medical Corps.
No. 3628 Serjt.-Major A. M. Watkins, Royal Army Medical Corps.
No. 8812 Acting-Serjt. W. R. Watson, Royal Army Medical Corps.
No. 319 Serjt.-Major J. Webb, Royal Army Medical Corps.
No. 27347 Qmr.-Serjt. J. Whitehead, Royal Army Medical Corps.
No. 570 Serjt.-Major R. Whitworth, Royal Army Medical Corps.
No. 66764 Pte. T. R. Winning, Royal Army Medical Corps.
No. 25930 Serjt.-Major M. Wyld, Royal Army Medical Corps.

APPOINTMENTS, COMMISSIONS, REWARDS, &c.

Approved by the Lieutenant-General Commanding-in-Chief, British Salonika Force. (Subject to War Office approval where authority is not quoted).

LIST No. 39.

General Headquarters,
British Salonika Force.
March 11, 1917.

HONOURS AND REWARDS.

Under authority granted by His Majesty the King to the Lieutenant-General Commanding-in-Chief, the following honours have been awarded for gallantry and devotion to duty in the Field, dated March 11, 1917 :—

Meritorious Service Medal.

No. 11082 Serjt.-Major (now temp. Lieut. and Qrmr.) J. Fraser, Royal Army Medical Corps.
No. 11565 Serjt.-Major J. H. Jones, Royal Army Medical Corps.
No. 14465 Qmr.-Serjt. (Acting-Serjt.-Major) Robert Cottey, Royal Army Medical Corps.
No. 2842 Pte. (Acting-Cpl.) Hubert Hard, Royal Army Medical Corps.
No. 62901 Pte. Benjamin Barker, Royal Army Medical Corps.
No. 12005 Pte. J. J. Jones, Royal Army Medical Corps.

LIST No. 41.

Military Medal.

No. 24598 Cpl. Ernest William Muffitt, Royal Army Medical Corps.
(The Rewards specified in the above List are granted in respect of services rendered from the date of Mobilization).

War Office,
April 17, 1917.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officer to be a Companion of the Distinguished Service Order in recognition of his gallantry and devotion to duty in the Field :—

Temp. Lieut. John Maximilian Hammond, M.B., Royal Army Medical Corps, attached Devonshire Regiment.

For conspicuous gallantry and devotion to duty in evacuating a large number of wounded under the most difficult conditions. He was himself subsequently wounded, and although both feet were practically blown off he ordered his stretcher-bearers to carry away another wounded man first.

His Majesty the King has been graciously pleased to award a Bar to the Military Cross to the undermentioned Officers :—

Temp Capt. Ernest Emrys Isaac, M.C., Royal Army Medical Corps. attached Royal Fusiliers.

For conspicuous gallantry and devotion to duty. He worked continuously under very heavy fire and was responsible for the successful evacuation of the wounded. He set a splendid example of courage and determination throughout the operations. (M.C. gazetted October 20, 1916).

Temp. Capt. Patrick Joseph Lane, M.C., M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. On several occasions he led out squads of stretcher-bearers under very heavy fire and succeeded in bringing in many wounded men. He set a splendid example of courage and determination throughout. (M.C. gazetted November 25, 1916.)

Capt. Rudolph Albert Peters, M.C., M.B., Royal Army Medical Corps, attached King's Royal Rifle Corps.

For conspicuous gallantry and devotion to duty. He continually tended the wounded under very heavy fire. He set a splendid example and showed an absolute disregard for his own personal safety. He has on many previous occasions done fine work. (M.C. gazetted October 20, 1916.)

Temp. Capt. John Caruthers Sale, M.C., Royal Army Medical Corps, attached Royal Fusiliers.

For conspicuous gallantry and devotion to duty. He displayed great courage in collecting and dressing the wounded in the face of a very heavy hostile barrage. He set a splendid example to all ranks. (M.C. gazetted November 25, 1916.)

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the Field :—

Temp. Capt. Victor Thomas William Eagles, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He organized and led search parties for wounded, and worked continuously under very heavy fire for over twenty-four hours. He set a splendid example of courage and determination throughout.

Capt. Norman Parsons Jewell, M.B., East African Medical Service.

For conspicuous gallantry and devotion to duty. He worked continuously for sixty-two hours, and, single-handed, attended to over 100 wounded men. He has on many previous occasions done fine work.

Temp. Lieut. Charles Gordon Kemp, M.B., Royal Army Medical Corps, attached Northern Regiment.

For conspicuous gallantry and devotion to duty. He worked unceasingly for two days under very heavy fire, and succeeded in evacuating a large number of wounded. He displayed great courage and determination throughout the operations.

Capt. Stanley James Linzell, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty in superintending the evacuation of the wounded. He continually visited the forward battalion headquarters, passing under very heavy fire. He set a splendid example of courage and determination throughout.

Temp. Capt. Thomas McCosh, M.B., Royal Army Medical Corps, attached Welsh Regiment.

For conspicuous gallantry when his aid-post was subjected to heavy shell fire for over three hours. He, with absolute disregard for his own personal safety, set a splendid example of courage and devotion to duty.

Temp. Capt. Herbert Walker, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He led his stretcher-bearers with great courage and determination for a period of thirty-six hours. It was due to his energy and resource that a large number of wounded were evacuated under the most trying conditions.

Australian Imperial Force.

Capt. Gladstone Montague Hunt, Army Medical Corps.

For conspicuous gallantry and devotion to duty. He showed an absolute disregard of danger and set a splendid example to his stretcher-bearers, working with them over ground continually swept by heavy fire. He worked for six consecutive weeks in a forward area in charge of an advanced dressing-station.

Capt. Harrie Bertie Lee, Army Medical Corps.

For conspicuous gallantry and devotion to duty in evacuating the wounded. He set a splendid example throughout and worked continually under very heavy fire. He has previously done fine work.

His Majesty the King has been graciously pleased to approve of the award of the Distinguished Conduct Medal to the undermentioned Man for an act of gallantry and devotion to duty in the Field :—

No. 12731 Pte. E. A. Ratty, Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He frequently led his squad out under very heavy fire, and succeeded in bringing in many wounded men. He has on many previous occasions done fine work.

AMENDMENTS.

The following are the correct ranks of certain Officers awarded the Distinguished Service Order and Military Cross respectively in the *London Gazette* of December 22, 1916.

Military Cross.

2nd Class Sub.-Asst. Surg. Copi-Nath Agarwal, I.S.M.D.
2nd Class Asst. Surg. James Michael Rodrigues, I.S.M.D.

His Majesty the King has been graciously pleased to approve of the award of a Bar to the Military Medal to the undermentioned Man :—

No. 63916 Pte. J. Todd, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned Non-commissioned Officers and Men :—

No. 74916 Pte. J. L. Akhurst, Royal Army Medical Corps.
No. 43203 Pte. D. Atkins, Royal Army Medical Corps.
No. 80998 Pte. T. W. Bowers, Royal Army Medical Corps.
No. 38511 Pte. (acting Lance-Cpl.) R. A. Broom, Royal Army Medical Corps.
No. 6079 Pte. (acting Serjt.) J. J. Cooley, Royal Army Medical Corps.
No. 9502 Acting Cpl. J. W. Dykes, Royal Army Medical Corps, attached Royal Engineers.
No. 59180 Pte. A. E. French, Royal Army Medical Corps.
No. 45631 Pte. F. W. Keeler, Royal Army Medical Corps.
No. 62149 Pte. C. R. Loretto, Royal Army Medical Corps.
No. 74852 Pte. (Acting Lance-Cpl.) F. Norris, Royal Army Medical Corps.
No. 1415 Pte. W. R. Prior, Royal Army Medical Corps.
No. 53738 Pte. S. Smyth, Royal Army Medical Corps.
No. 37653 Pte. (acting Lance-Serjt.) S. Tranter, Royal Army Medical Corps.

War Office,
April 21, 1917.

The following are among the Decorations and Medals awarded by the Allied Powers at various dates to the British Forces for distinguished services rendered during the course of the campaign :—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question :—

DECORATIONS CONFERRED BY HIS MAJESTY THE KING OF THE BELGIANS.

Ordre de la Couronne.

Officer : Capt. Stewart Ranken Douglas, late Indian Medical Service, St. Mary's Hospital.

Officer : Temp. Col. Almroth Edward Wright, C.B., M.D., Army Medical Service, St. Mary's Hospital.

Chevalier : Temp. Lieut. Eric Shaw, M.B., Royal Army Medical Corps.

DECORATIONS AND MEDALS CONFERRED BY H.M. THE KING OF SERBIA, IN RECOGNITION OF SERVICES DURING THE OPERATIONS IN SERBIA IN NOVEMBER AND DECEMBER, 1915.

Order of the White Eagle, 4th Class.

Lieut.-Col. Edwin Thomas Fairbrother Birrell, C.M.G., M.B., Royal Army Medical Corps.

Major Mortimer John Cromie, Royal Army Medical Corps.

Cross of Karageorge, 2nd Class Silver Star (with Swords).

No. 51303 Serjt.-Major George Samuel Harrington, Royal Army Medical Corps.

Order of St. Sava.

Temp. Lieut. Robert MacKenzie Morison, M.B., Royal Army Medical Corps.

DECORATION CONFERRED BY H.H. THE SULTAN OF EGYPT.

Order of the Nile, 3rd Class.

Major Robert Grenville Anderson, Royal Army Medical Corps, late Assistant Adjutant-General, Recruiting Department, Egyptian Army.

Major William Byam, Royal Army Medical Corps, late Medical Corps, Egyptian Army.

Order of the Nile, 4th Class.

Capt. Edward Gibbon, M.B., Royal Army Medical Corps, attached Medical Corps, Egyptian Army.

War Office,
April 26, 1917.

His Majesty the King has been graciously pleased to approve of the appointment of the undermentioned Officer to be a Companion of the Distinguished Service Order in recognition of his gallantry and devotion to duty in the Field:—

*Capt. Allan Watson, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He went forward under very heavy fire, before his own unit was ordered to advance, and commenced to dress the wounded of another battalion. He worked untiringly under fire both day and night, never resting until all the wounded had been brought in.

(The name marked with an asterisk appeared in the *London Gazette*, dated March 17, 1917, without deeds.)

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officer in recognition of his gallantry and devotion to duty in the Field:—

AUSTRALIAN IMPERIAL FORCE.

Capt. John Hardie, Army Medical Corps.

For conspicuous gallantry and devotion to duty. He attended a large number of wounded at the aid-posts under heavy fire and continued at work after being wounded himself in two places. He set a fine example throughout.

His Majesty the King has been graciously pleased to approve of the undermentioned reward for Distinguished Service in the Field of Mesopotamia.

AWARDED THE MILITARY CROSS.

Temp. Lieut. Erach Ruttonji Daboo, Indian Medical Service.

His Majesty the King has been graciously pleased to award the Military Medal for Bravery in the Field to the undermentioned Non-Commissioned Officers and Men:—

No. 64484 Pte. H. H. Barlow, Royal Army Medical Corps.
No 2757 Pte. W. Bissenden, Royal Army Medical Corps.
No. 512311 Pte. P. E. Bolingbroke, Royal Army Medical Corps (formerly No. 434).
No. 172 Cpl. G. H. Davies, Royal Army Medical Corps.
No. 27976 Pte. (Acting Lance-Cpl.) E. A. Davis, Royal Army Medical Corps.
No. 512229 Pte. S. I. Dean, Royal Army Medical Corps (formerly No. 301).
No. 512139 Cpl. E. J. Dillon, Royal Army Medical Corps (formerly No. 152).
No. 31522 Pte. G. H. Fell, Royal Army Medical Corps.
No. 60277 Serjt. A. W. Franklin, Royal Army Medical Corps.
No. 1320 Serjt. P. Gill, Royal Army Medical Corps.
No. 39625 Capt. (Acting Serjt.) J. G. Gore, Royal Army Medical Corps.
No. 2773 Lance-Cpl. J. T. Hadlow, Royal Army Medical Corps.
No. 50228 Serjt. H. F. Houlder, Royal Army Medical Corps.
No. 2622 Pte. M. J. Jacobs, Royal Army Medical Corps.
No. 43664 Pte. W. Mitchell, Royal Army Medical Corps.
No. 24598 Pte. (Cpl.) E. W. Muffitt, Royal Army Medical Corps.
No. 47484 Pte. A. H. Pickrell, Royal Army Medical Corps.

No. 12731 Pte. (Acting Lance-Corpl.) E. A. Ratty, Royal Army Medical Corps.
No. 66599 Pte. (Acting Cpl.) W. Smith, Royal Army Medical Corps.
No. 56614 Acting Lance-Cpl. J. Spittle, Royal Army Medical Corps.
No. 2762 Pte. F. P. Tickner, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to award the Meritorious Service Medal to the undermentioned Warrant Officers, Non-Commissioned Officers and Men, in recognition of valuable services rendered with the Armies in the Field during the present War:—

No. 62901 Pte. B. Barker, Royal Army Medical Corps.
No. 14465 Qmr.-Serjt. (Acting Serjt.-Major) R. Cottey, Royal Army Medical Corps.
No. 11082 Serjt.-Major (now Temp. Lieut. and Qmr.) J. Fraser, Royal Army Medical Corps.
No. 2842 Pte. (Acting Cpl.) H. Hard, Royal Army Medical Corps.
No. 510039 Pte. H. H. Hughes, Royal Army Medical Corps (formerly No. 1192).
No. 11565 Serjt.-Major J. H. Jones, Royal Army Medical Corps.
No. 12005 Pte. J. J. Jones, Royal Army Medical Corps.
No. 105 Qmr.-Serjt. (Acting Serjt.-Major) W. Parker, Royal Army Medical Corps.
No. 327 Pte. J. Renninson, Royal Army Medical Corps.

War Office,
May 1, 1917.

The following are among the Decorations and Medals awarded by the Allied Powers at various dates to the British Forces for distinguished services rendered during the course of the campaign:—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

Decorations conferred by the President of the French Republic.

Légion d'Honneur.

Croix de Chevalier.

Qmr. and Honorary Major Harry Woodburne Blaylock, Canadian Army Medica Corps.
Qmr. and Honorary Captain Edward John Buckley, Royal Army Medical Corps.
Capt. Vivian Bartley Green-Armytage, M.D., M.R.C.P., Indian Medical Service.
Lieut.-Col. Arthur Mignault, Canadian Army Medical Corps.

Croix de Guerre.

Capt. Arthur Chester Armstrong, Canadian Army Medical Corps.
Temp. Capt. Hugh Llewellyn Glyn Hughes, D.S.O., Royal Army Medical Corps.
Temp. Capt. Benjamin Bell Noble, M.B., Royal Army Medical Corps.
Temp. Capt. Ronald Russell Scott, M.B., Royal Army Medical Corps.
Temp. Capt. (temporary Major) Arthur George Whitehorne-Cole, Royal Army Medical Corps.
Major Herbert Henry Woollard, Australian Army Medical Corps.
No. 9698 Pte. John Bee, Royal Army Medical Corps.
No. 73849 Pte. Richard Brown, Royal Army Medical Corps.
No. 1569 Lance-Cpl. (Acting Cpl.) Sydney Francis Goodman, Royal Army Medical Corps.
No. 68816 Pte. Melville Scott Lockhart, Royal Army Medical Corps.
No. 11755 Serjt. Joseph Paulizky, Royal Army Medical Corps.
No. 48176 Pte. (Acting Lance-Cpl.) Gwilym Ivor Rees, Royal Army Medical Corps.
No. 2055 Cpl. Richard Welman Treeby, Royal Army Medical Corps.

Médaille Militaire.

No. 80 Pte. Fred Jackson, Royal Army Medical Corps.
No. 12618 Staff-Serjt. William Austin Mayman, Royal Army Medical Corps.
No. 18219 Pte. (Acting Cpl.) David James Robertson, Royal Army Medical Corps.
No. 1766 Pte. Frank Alfred Smeed, Royal Army Medical Corps.
No. 66304 Pte. John Vanderslys Thomas, Royal Army Medical Corps.
No. 9467 Serjt.-Major (now Temp. Qmr. and Hon. Lieut.) Charles James Tunn, Royal Army Medical Corps.
No. 61135 Pte. (Acting Cpl.) William Uzzell, Royal Army Medical Corps.

Croix d'Officier.

Col. Henry Davis Rowan, M.B., Army Medical Service.

Croix de Guerre.

Temp. Lieut. St. John Dudley Buxton, Royal Army Medical Corps,

Temp. Capt. Kenneth Grant Fraser, Royal Army Medical Corps.

Temp. Capt. William Alfred Leslie Harrison Henderson, M.B., Royal Army Medical Corps.

No. 15843 Qmr-Serjt. (Acting Serj.-Major) William Stokes, Royal Army Medical Corps.

Médaille Militaire.

No. 2100 Serjt. Erle Brett Trotter, Royal Army Medical Corps.

ARMY MEDICAL SERVICE.

Col. James H. Daly is retained on the active list under the provisions of Arts. 120 and 522 Royal Warrant for Pay and Promotion, 1914, and to be supernumerary, dated April 13, 1917.

ROYAL ARMY MEDICAL CORPS.

Lieut.-Col. Henry W. Grattan to be Temp. Col. whilst employed as Assistant Director Medical Services of a Division, dated March 29, 1917.

Capt. Charles W. Bowle relinquishes the acting rank of Lieut.-Col. on re-posting, dated February 28, 1917.

Lieut.-Col. Thomas H. J. C. Goodwin, C.M.G., D.S.O., to retain the acting rank of Col. whilst employed as an Assistant Director of Medical Services at the War Office, dsted April 8, 1917.

The undermentioned to be acting Lieut.-Col. :—

Dated March 25, 1917.—Major Nelson Low, D.S.O., whilst commanding a Casualty Clearing Station.

The undermentioned Lieut.-Col. to be Acting Col. whilst employed as Assistant Director of Medical Services of a Division :—

Dated March 18, 1917.—George St. C. Thom, C.M.G., M.B.; John W. H. Houghton, M.B. .

The undermentioned Capts. to be Acting Lieut.-Cols. whilst commanding a Field Ambulance :—

Dated August 22, 1916.—Wilfred J. Dunn, M.B.

Dated November 7, 1916.—(Acting Major) William J. Tobin.

Capt. Robert C. Carlyle, M.B., is seconded for service with Egyptian Army, dated February 10, 1917.

Lieut.-Col. Frederick F. Carroll, D.S.O., from the seconded list, is placed on half pay, dated March 19, 1917.

ROYAL ARMY MEDICAL CORPS OFFICERS' BENEVOLENT SOCIETY.

PROCEEDINGS OF A COMMITTEE MEETING HELD ON THURSDAY, APRIL 12, 1917, IN ROOM 313, ADASTRAL HOUSE.

Present :

Surg.-Gen. Sir Alfred Keogh, G.C.B., President, in the Chair.
Surg.-Gen. M. W. Russell, C.B.
The Secretary.

Letters of apology for non-attendance were read from Surg.-Gen. Sir David Bruce, C.B., and Lieut.-Col. A. B. Cottell.

(1) The Minutes of the last meeting were read and confirmed.

(2) It was noted that the Annual General Meeting will be held at the Royal Army Medical College, in the Library, on Monday, June 11, at 3 p.m.

(3) It was noted that the following donations were received during the past quarters for the Society :—

Officers' Mess, Royal Army Medical Corps Training Centre, Ripon ..	£20
Lieut.-Col. and Mrs. Brunskill ..	5

(4) The Committee considered the applications for grants for the current year, and recommended the following for consideration :—

Orphan of Surg.-Major C. Q. ..	£30
Orphan of Surg.-Gen. A. S. ..	20
Orphan of Surg.-Gen. J. O. ..	40
Orphan of Surg.-Gen. W. F. I. ..	40
Orphan of Surg.-Gen. T. B. ..	40
Orphan of Surg.-Major B. C. S. ..	35
Orphan of Major P. G. I. (McGrigor's Pension) ..	10
Three orphans of Capt. G. C. ..	40
Orphan of Surg.-Gen. R. A. C. ..	40
Orphan of Surg.-Gen. J. W. M. ..	20
Orphan of Surg.-Gen. J. F. ..	30
Two orphans of Surg.-Gen. W. T. H. ..	30
Seven orphans of Lieut.-Col. J. W. ..	30
Orphan of Lieut.-Col. R. G. H. ..	20
Orphan of Capt. T. S. ..	20
Two orphans of Capt. D. O'C. ..	20
Two orphans of Lieut.-Col. T. M. C. ..	40
Orphan of Lieut.-Col. A. T. ..	30
Two orphans of Major C. J. H. ..	30
Orphan of Staff-Surg. J. W. C. ..	25
Orphan of Surg.-Gen. A. W. B. ..	20
Orphan of Capt. H. H. S. ..	15
Two orphans of Capt. F. M. M. O. ..	20
Twenty-three applications representing thirty-six orphans ..	£645

124, *Victoria Street*,
S.W. 1.

F. W. H. Davie Harris,
Lieut.-Col., Secretary.

Notice of the Annual General Meeting, 1917.

The Annual General Meeting of subscribers to this Society will be held in the Library of the Royal Army Medical College, Grosvenor Road, S.W., at 3 p.m., on Monday, June 11, 1917. The Director-General will preside.

It is hoped that all subscribers will freely express their views on any point connected with the Society. Those subscribers who may wish for information on any special point are requested to communicate with the Secretary, so that the necessary information may be furnished in response to any questions asked.

124, *Victoria Street*,
S.W. 1.

F. W. H. Davie Harris,
Lieut.-Col., Secretary.

ROYAL ARMY MEDICAL CORPS FUND.

Proceedings of a Committee Meeting held on Thursday, April 12, 1917, in Room 313, Adastral House.

Present :

Surg.-Gen. M. W. Russell, C.B., in the Chair.
Major Sir Edward Worthington, C.M.G., M.V.O.
Major W. Ward.

A letter of apology for absence was read from Surg.-Gen. Sir David Bruce, C.B.

(1) The Minutes of the last meeting were read and confirmed. Arising from Minute 3 of the last meeting a letter was read from the Bankers, saying that holdings in the New War Loan could only be registered or inscribed in the names of individuals; it was therefore necessary that the security of the War Loan belonging to the Royal Army Medical Corps Fund should be retained in bearer form.

(2) It was noted that the Annual General Meeting of the Fund will be held in the Library of the Royal Army Medical College on Monday, June 11, at 2.30 p.m.

(3) The Band Accounts for the past quarter and the quarter ending December 31 last were considered, amended and approved. The Secretary was requested to inform the new Band President that a sum of £100 was voted at the last meeting towards the upkeep of the Band for this year. The accounts are appended to these Proceedings.

(4) With reference to Minute 7 of the last meeting a letter was read from Lieut.-Col. G. Mansfield thanking the Committee for electing him, but declining the vacant seat on the Committee; he lives at Jersey and would be unable to attend the meetings.

It was resolved that Col. C. R. Tyrrell be asked to represent retired officers on the Committee, vice Lieut.-Col. W. W. Pope.

(5) Sanction was given for the expenditure of £6 15s. for payment of the account for sending Easter cards to the Medical Staff of the Russian Army from the Officers of the Royal Army Medical Corps.

(6) It was noted that £208 13s. 8d. was received in grants from Companies for the General Relief Fund during the past quarter. A list of the contributors is attached thereto.

(7) It was resolved that another £400 War Loan be purchased for the Royal Army Medical Corps Fund, making a total holding of £2,200 of that security for the Royal Army Medical Corps Fund besides that held by the Trustees of the General Relief Fund.

124, *Victoria Street*,
S.W. 1.

F. W. H. Davie Harris,
Lieut.-Col., Secretary.

Grants received for the General Relief Fund during the Quarter ending March 31, 1917.

	£	s.	d.
(1) Royal Army Medical Corps Mess, Birr	10	0	0
(2) ,, ,, ,, ,, Whalley	60	0	0
(3) 8th Field Ambulance,	2	10	0
(4) 13th ,, ,,	16	2	6
(5) 15th Stationary Hospital	71	1	2
(6) 1st Casualty Clearing Station	9	0	0
(7) 11th ,, ,, ,,	30	0	0
(8) 36th General Hospital Christmas Offertories	5	0	0
(9) 43rd General Hospital	5	0	0
	£208	13	8

Notice of the Annual General Meeting, 1917.

The Annual General Meeting of subscribers to this Fund will be held in the Library of the Royal Army Medical College, Grosvenor Road, S.W. 1, at 2.30 p.m., on Monday, June 11, 1917.

It is hoped that all subscribers will freely express their views on any point connected with the Fund. Those officers who may wish for information on any special point are requested to communicate with the Secretary, so that the necessary information may be furnished in response to any question asked.

124, *Victoria Street*,
S.W. 1.

F. W. H. Davie Harris,
Lieut.-Col., Secretary.

ROYAL ARMY MEDICAL CORPS.

BAND FUND.

Half-year ending March 31, 1916.

RECEIPTS.

1916.		£	s.	d.
June 30.	By Balance per Pass Book, December 30, 1916	152	10	0
	Cash in hand	5	0	3
	By subscriptions, R.A.M.C. Officers, Aldershot	19	6	0
	Band Fees	37	3	0
October 11.	By Cheque, R.A.M.C. Band Fund	125	0	0
		£338	19	3

EXPENDITURE.

	£	s.	d.	£	s.	d.
To Bandmaster's Salary for Half-year	70	0	0			
,, Serjt. Smith, Pay for Half-year	10	14	0			
				80	14	0
Fees to Band for Engagements	28	10	0			
Pay to Bandsmen	19	5	0			
Band Fares to Aldershot Traction Company	2	10	0			
				50	6	0
Phœnix Assurance Company, and Foster and Wells Premiums on Policies				2	17	9
Petty Cash				5	0	0
Cheque Book				0	4	2
Uniform and Overcoat, etc. (Bandmaster)				8	5	0
Music Repairs and Programmes for Half-year				16	7	0
Mr. Bradley, Expenses				1	2	6
Incidental Expenses				5	0	3
Balance in hand, December 31, 1916				169	2	7
				£338	19	3

THE ROYAL ARMY MEDICAL CORPS.

BAND FUND.

Quarter ending March 31, 1917.

RECEIPTS.

Date		£	s.	d.
March 3, 1916.	By Balance	169	2	7
January 1, 1917.	Hon. Secretary, Officers' Club for Dance, December 16, 1916 ..	5	0	0
,, 18, 1917.	Officers' Club Fee for Dance, January 6, 1917	5	0	0
,, 31, 1917.	R.A.M.C. Officers, Aldershot ..	3	10	0
,, 31, 1917.	Senior Officers' School, Marlboro Lives, Band Fee	3	3	0
,, 31, 1917.	Officers' Club, Aldershot, Fee for Dance, January 27, 1917	5	0	0
February 14, 1917.	R.A.M.C. Officers, Aldershot ..	3	15	0
,, 25, 1917.	Officers' Club, Fees for Band at Dance, February 17. 1917 ..	5	0	0
,, 2, 1917.	From London Account for Petty Cash Account	4	0	0
		£203	10	7

EXPENDITURE.

Date		£	s.	d.
February 2, 1917 March 3, 1917 ,, 31, 1917	To Bandmaster's Salary, quarter ending March 31, 1917	30	0	0
February 2, 1917 March 5, 1917 ,, 31, 1917	Bugler-Serjt. Smith's Pay	4	10	0
January 4, 1917 ,, 18, 1917 ,, 31, 1917	Fees to Band for Engagements, etc.	28	5	0
,, 31, 1917 March 31, 1917	Messrs. Hawkes and Sons, Music Repairs, etc.	41	15	4
,, 31, 1917.	Joseph Higham, Ltd., Repairs ..	1	1	0
February 2, 1917.	Self, for Petty Cash Account ..	4	0	0
	Balance Credit	89	19	3
	Petty Cash.			
February 2, 1917.	Boosey and Co.	0	2	10
,, 2, 1917.	Storeman's Pay, January	0	5	0
,, 2, 1917.	Ptes. Cons and Fable, Repair of Instruments	0	7	0
,, 13, 1917.	Keith Prowse and Co., Music ..	0	5	10
March 11, 1917.	Pte. Weatherald, Fare to Manchester	0	5	0
,, 16, 1917.	Storeman's Pay for February ..	0	5	0
,, 16, 1917.	Sharples and Sons, Repairs ..	0	5	0
,, 31, 1917.	Storeman's Pay for March	0	5	0
,, 31, 1917.	Messrs. Sharples, Repairs	0	1	9
,, 31, 1917.	A. Cook, Music	0	1	6
,, 31, 1917.	J. Davis, Repairs	0	4	0
,, 31, 1917.	Bickerstaffe, Repairs to Bass Fiddle	0	16	6
,, 31, 1917.	Sharples, Music Paper	0	2	8
,,	Pte. Constable, Repairs and Tuning Piano	0	5	6
,, 31, 1917.	Wine to Hawkes, *re* Music	0	1	10
,, 31, 1917.	Postage for Quarter	0	1	10
	Balance Credit, Petty Cash	0	3	8½
		£203	10	7

ROYAL ARMY MEDICAL CORPS CENTRAL MESS FUND.

SUMMARY OF PROCEEDINGS OF A MEETING OF THE COMMITTEE HELD AT THE WAR OFFICE ON MAY 9, 1917.

Present.

Major W. A. Ward, representing Aldershot, in the Chair.
Major G. A. D. Harvey, representing Curragh.
Capt. H. G. Gibson, representing London.
Capt. H. S. Dickson, representing Woolwich.

(1) The minutes of the previous meeting were read and confirmed.

(2) The accounts for the year 1916-17 were examined, and adopted unanimously.

(3) Payment of audit fee to Mr. E. T. Gann was sanctioned.

(4) An application for help from the Committee of the Aldershot mess was considered. It was pointed out that owing to the extremely small number of dining members the funds available for the proper maintenance of the mess were very limited: also that the furniture of this mess is its own property. A detailed statement of accounts was submitted in support of the application.

It was resolved unanimously that a grant of £5 per mensem for the current year, from April 1, 1917, be made to the Aldershot Mess Committee, for the purpose of maintenance, such grant to be payable by quarterly instalments in advance.

(5) The Hon. Secretary Aldershot Mess brought forward the case of the widow and five orphans of the late Mr. George Stacey, who had been left by his death in need of help. Mr. Stacey was for twenty-six years a mess servant at Netley and Aldershot. Resolved that a grant of £15 be made towards the immediate relief of Mrs. Stacey and her children, pending the response which it is hoped will be given to the appeal which is being made for this purpose. The application of this grant to be left to the Hon. Secretary of the Aldershot Mess.

(6) The Hon. Secretary was authorized to pay an outstanding debt of £6 6s. 2d., due by officers Royal Army Medical Corps Scottish Command to the Army and Navy Co-operative Society, being balance due for camp canteen purchased in 1914.

(7) Payment to the Hon. Secretary of £2 7s. 11d. in respect of petty cash expended by him in the period January, 1916, to May, 1917, was sanctioned.

(8) Realization of Exchequer Bonds, held by Messrs. Holt and Co. for the Fund, was sanctioned if the cash balance at the bankers should sink below the customary level.

3, *Homefield Road,*
Wimbledon.

J. T. CLAPHAM, *Captain,*
Hon. Secretary.

ROYAL ARMY MEDICAL CENTRAL MESS FUND.

THE Annual General Meeting of Subscribers to this Fund will be held in the Library of the Royal Army Medical College on Monday, June 11, 1917, following the meeting of the Royal Army Medical Corps Officers' Benevolent Society.

3, *Homefield Road,*
Wimbledon.

J. T. CLAPHAM, *Capt.,*
Hon. Sec.

ROYAL ARMY MEDICAL CORPS CENTRAL MESS FUND.

Dr. CASH STATEMENT FOR THE YEAR ENDING FEBRUARY 28, 1917. **Cr.**

Income.

		£ s. d.	£ s. d.
1916 Mar. 1.	To Balance of Cash brought forward from 1915-1916		525 19 4
	,, Balance of Loan repaid by Aldershot Mess Committee		60 0 0
	,, Interest on Investments		21 0 0
	,, Subscriptions of Members (779)	£572 7 0	
	Less Refund of Subscription for 1915-16	0 7 3	571 19 9
			£1,178 19 1

Expenditure.

		£ s. d.	£ s. d.
1916	By Grants to Messes: London	83 4 6	
	Peshawar	50 0 0	133 4 6
	,, Joining, and difference-in-rank Contributions Paid to Messes on behalf of Subscribers—		
	Aldershot	£22 16 0	
	Rawal Pindi	12 13 0	35 9 0
	,, Audit Fee		3 3 0
	,, Purchase of £200 Exchequer 5 per cent. Bonds, 1920..	200 0 0	
	,, Purchase of £100 Exchequer 5 per cent. Bonds, 1921..	100 0 0	
	,, Purchase of £200 Exchequer 6 per cent. Bonds, 1920..	200 0 0	
	,, Purchase of £400 War Loan 5 per cent. Bonds, 1929-47	380 0 0	880 0 0
	(*Note*—The above £300 Exchequer 5 per cent Bonds, together with £400 Exchequer 5 per cent. Bonds purchased last year, are in process of conversion into War Loan 5 per cent. Bonds 1929-47, producing £736 16s. 9d. of the latter)		
1917 Feb. 28.	Balance of Cash carried forward to 1917-18		127 2 7
			£1,178 19 1

BALANCE SHEET AT FEBRUARY 28, 1917.

Liabilities.

	£ s. d.
Balance..	1,463 19 4
	£1,463 19 4

Assets.

	£ s. d.
£200 Exchequer 6 per cent. Bonds 1920 ..	200 0 0
* £1,136 16s. 9d. War Loan 5 per cent. Bonds 1929-47	1,136 16 9
Cash at Bankers	127 2 7
* See note above.	
	£1,463 19 4

Audited and found correct
(Signed) EDMOND T. GANN.

March 26, 1917.

(Signed) J. T. CLAPHAM, *Captain*,
Hon. Secretary.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

SUMMARY OF THE PROCEEDINGS OF A QUARTERLY MEETING OF THE COMMITTEE HELD AT THE ROYAL ARMY MEDICAL COLLEGE ON APRIL 17, 1917.

Present:

Dep. Surg.-Gen. W. G. Don, Vice-President, in the Chair.
Surg.-Gen. W. S. M. Price, Vice-President.
Lieut.-Col. J. More Reid.
Lieut.-Col. G. S. Mansfield.
Major P. S. O'Reilly.
Capt. W. C. Smales, D.S.O.
Capt. W. F. M. Loughnan, M.C.

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(1) The Minutes of the previous meeting were read and confirmed.

(2) Payment of annuities according to list submitted was sanctioned.

(3) The Accounts and Balance Sheets for the year 1916, as audited by Deloitte and Co., were submitted and unanimously adopted, as was also the Report.

(4) Payment of the audit fee (£10 10s.) to Messrs. Deloitte and Co. was sanctioned.

(5) The date and place of the Annual General Meeting were fixed for Tuesday, May 22, at the Royal Army Medical College, at 3 p.m.

(6) The Secretary made a statement as to the Funds of the Society, which will be found in the Annual Report.

(7) The Secretary was authorized to take the necessary steps to adjust the total holding so as to bring it to round hundreds if desirable, and if the cash balance permitted.

(8) The Committee then considered the desirability of reducing the extra war charge, at present fifty guineas per annum, in addition to the normal annual subscription according to scale. The Secretary submitted figures which showed that the death rate of regular officers of the Corps had been less than was expected during the later stages of the war, whilst the income of the Society had been increased by recent charges in investment. He also submitted a letter from the Consulting Actuary in which the latter expressed the opinion that the Committee would be justified in reducing the extra charge to new members from fifty to twenty-five guineas per annum, reserving the right to increase the charge again if found necessary. After consideration it was resolved unanimously that the present extra war charge of fifty guineas per annum be reduced to one of twenty-five guineas per annum in the case of officers on the strength of the Corps at the ourbreak of war; the right of increasing the charge to future new members, if necessary, being reserved. Also that a refund of an equivalent proportion of their subscriptions be made to such members as have already paid the extra war charge. The advisability of making such officers, at present 111 in number, as have been gazetted to permanent commissions in the Corps since the outbreak of war eligible for membership was considered. The question was deferred pending further information as to the number of them married or serving in the danger zone, as to which the Secretary was directed to make further inquiry.

(9) Payment of the Secretary's salary for the quarter ending March 31 was sanctioned, as was that of office allowance and petty cash.

3, *Homefield Road,*
Wimbledon, S.W.

J. T. CLAPHAM, *Captain,*
Secretary.

REPORT OF THE COMMITTEE OF MANAGEMENT TO THE MEMBERS OF THE ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND FOR THE YEAR ENDED DECEMBER 31, 1916.

The Committee have the honour to present the following Report on their proceedings and to submit the accounts of the Society for the year ended December 31, 1916.

At the Annual General Meeting held in May, 1916, Colonels Sir William Leishman and S. Guise Moores were re-elected members of the Committee, and Lieut.-Col. J. More Reid was elected in place of the iate Surg.-Gen. Sir Charles Cuffe.

During the past year no deaths were reported amongst members of the Society, but five annuitants have died. One member resigned and two married members

joined the Society; two were transferred from the unmarried to the married list, and one married member having lost his wife, continues his subscription for the benefit of his children.

During the year 1916, £1,000 from cash balances was invested in Exchequer five per cent. Bonds. The interest on the deposit with the National Debt Commissioners amounted for the year to £3,868 17s. 4d. On the other hand, £1,200 was withdrawn for payment of annuities.

In the early months of the current year, 1917, considerable changes have taken place in the investments of the Society, consequent on the issue of the five per cent War Loan, 1929/47. It may be remembered that when the four and a half per cent War Loan was issued in 1915 the Committee had under consideration the withdrawal of the whole deposit with the National Debt Commissioners, in order to invest it in that Stock, but in deference to the strongly expressed wish of the Chancellor of the Exchequer they refrained from withdrawing more than sufficed (£6,600) to allow of the conversion of the Consols held by the Society into a four and a half per cent War Stock. But on the occasion of the issue of the present five per cent War Loan (1929/47) the Committee felt bound in the interest of the Society to renew their request for the withdrawal of the whole then balance, amounting, with interest, to £104,386 18s. 9d. This, with the addition of £1,466 16s. 3d., from cash balances, was invested in War Loan five per cent. Stock 1929/47 at 95, producing £111,425 of that Stock. In addition, the £10,000 four and a half per cent. War Stock (1925/45) and £1,000 five per cent. Exchequer Bonds are now in process of conversion, which will bring the total holding in five per cent. War Loan (1929/47) to approximately £123,000. Through these investments the income of the Society is increased by £1,600 per annum. In order to avoid the recurring expense of transfer on a change of Trustees these sums are now inscribed in the name of the Society in the books of the Post Office Savings Bank, instead of, as before, in those of the Bank of England, under provision of the War Loan (Supplemental Provisions) Act, 1915.

The £5,500 Dominion of Canada three and a-half per cent. Stock 1930/50 has been deposited with H.M. Treasury under the Regulation of Foreign Exchanges Act, by which the interest is increased one-half per cent.

The question of reducing the extra war charge of £52 10s. per annum, paid by members joining after the outbreak of war, was considered in July 1916, but in view of the uncertainty of the casualty rate in the large operations then beginning it was not considered advisable to alter the existing rate. The number of such casualties having proved less than was expected, and the financial position of the Society being most satisfactory, the Committee, with the concurrence of the Actuary, have been able to reduce the extra war charge by fifty per cent to twenty-five guineas per annum, and to make an equivalent refund to the five members who have already paid the full charge.

It has been ascertained that 111 officers have received permanent commissions in the Corps, dated January 1, 1917. Under present ruling they are not eligible to join the Society, but the matter is receiving the consideration of the Committee.

Royal Army Medical College,
April 17, 1917.

W. G. Don, *Dep. Surg. Gen., Ret.,*
Vice-President,
Chairman of the Meeting of this date.

NOTICE.

At a meeting of the Committee of this Society, held on April 17, it was unanimously resolved that the present extra war charge of fifty guineas per annum be reduced to one of twenty-five guineas per annum in addition to the normal annual subscription according to scale, as regards Officers on the strength of the Corps at the outbreak of war; the case of those who have since been gazetted to permanent commissions is under consideration. Also that a refund of a sum equal to half the extra war charges paid by them be made to those who have joined the Society since the beginning of the war. The right of increasing the charge to future new members, if necessary, is reserved.

The Annual General Meeting will be held at the Royal Army Medical College on Tuesday, May 22, at 3 p.m.

3, *Homefield Road,*
Wimbledon, S.W. 19.

J. T. Clapham, *Captain,*
Secretary.

ARMY MEDICAL OFFICERS' WIDOWS AND ORPHANS FUND.

ACCOUNTS FOR THE YEAR 1916.

(In the form prescribed for the Annual Return of a Registered Friendly Society.)

(A) BENEFIT FUND.

Dr. Income.	£	s.	d.	Expenditure. Cr.	£	s.	d.
Members' Subscriptions..	2,248	2	5	Widows' Annuities	3,485	5	0
Interest on Investments of Benefit Fund (including amounts recoverable in respect of Income Tax) ..	5,457	2	1	Interest on £5,407 11s. 1d. (balance of Management Fund at the end of the year 1915) at 3 per cent, transferred to Management Fund ..	162	4	6
Total Income ..	£7,705	4	6	Reserve from Surplus Funds at Quinquennial Valuation, transferred to Management Fund ..	592	8	11
Amount of Benefit Fund at the beginning of the year, as per last Balance Sheet	134,722	18	3	Interest on £592 8s. 11d. (as above) transferred to Management Fund ..	17	15	6
				Total Expenditure ..	£4,257	13	11
				Amount of Benefit Fund at the end of the year, as per Balance Sheet (C)	138,170	8	10
	£142,428	2	9		£142,428	2	9

(B) MANAGEMENT FUND.

Dr. Income.	£	s.	d.	Expenditure. Cr.	£	s.	d.
Reserve from Surplus Funds at Quinquennial Valuation, transferred from Benefit Fund ..	592	8	11	Secretary's Salary	150	0	0
				Office Allowance..	60	0	0
Interest on £592 8s. 11d. for one year, at 3 per cent, transferred from Benefit Fund	17	15	6	Actuary's Fees (including Valuation Fee)	73	10	0
				Auditors' Fee	10	10	0
Interest for one year on £5,407 11s. 1d. at 3 per cent, transferred from Benefit Fund	162	4	6	Printing, Postages, and Stationery	17	7	2
				Registration of Bonds ..	0	5	0
Total Income ..	772	8	11	Total Expenditure ..	£311	12	2
Amount of Management Fund at the beginning of the year, as per last Balance Sheet (C)	5,407	11	1	Amount of Management Fund at the end of the year, as per Balance Sheet (C)	5,868	7	10
	£6,180	0	0		£6,180	0	0

(C) BALANCE SHEET AT DECEMBER 31, 1916.

Dr.

Liabilities.	£	s.	d.
Benefit Fund, as per Account (A)	138,170	8	10
Management Fund, as per Account (B)	5,868	7	10
Sundry Liabilities—			
Actuary's Fee	10	10	0
Secretary's Salary and Office Allowance (from October 1 to December 31, 1916)	52	10	0
Annuities outstanding	97	10	0
	£144,199	6	8

To the Members of the Army Medical Officers' Widows and Orphans Fund.

We have examined the above Balance Sheet with the Books and Vouchers of the Society and certify that it is in accordance therewith. The Securities and Cash Balances have been verified by us.

DELOITTE, PLENDER, GRIFFITHS AND CO., *Auditors, Chartered Accountants.*

5, *London Wall Buildings, Finsbury Circus, E.C.*
April 12, 1917.

Cr.

Assets. Investments.	Rate per cent of Interest yielded £ s. d.	£	s.	d.
(1) With the Commissioners for the Reduction of the National Debt— Old Account, at 2½d. per cent. per diem	3 16 0½	103,524	4	9
(2) In the Public Funds—				
£10,000 0 0 War Loan, Four and a Half per Cent Stock, 1925-1945	4 12 8	9,712	10	0
1,000 0 0 Exchequer Five per Cent Bonds, 1920	5 0 0	1,000	0	0
5,500 0 0 Dominion of Canada Three and a Half per Cent Stock, 1930-1950	4 17 3	3,958	5	8
2,000 0 0 Newfoundland Three and a Half per Cent Stock, 1950	4 16 1	1,456	17	6
(3) Upon the Security of Borough and County Rates, or other Corporate Funds—				
5,000 0 0 London County Council Three and a Half per Cent Stock	4 9 10	3,893	15	0
5,000 0 0 Metropolitan Water Board "B" Three per Cent Stock	4 12 1	3,259	7	6
(4) Other Securities—				
5,000 0 0 Great Western Railway Four per Cent Debenture Stock	4 15 2	4,200	0	0
5,000 0 0 London and North Western Railway Three per Cent Debenture Stock	4 13 4	3,215	12	6
1,500 0 0 Caledonian Railway Four per Cent Debenture Stock	4 13 4	1,286	5	0
7,900 0 0 Midland Railway Two and a Half per Cent. Debenture Stock	4 15 8	4,130	4	4
2,100 0 0 East Indian Railway Three and a Half per Cent Debenture Stock	4 17 7	1,506	15	0
Note.—A Valuation of the above Securities at middle published prices on December 31, 1916, shows a depreciation of £1,480 12s. 6d.				
Interest accrued on Investments		982	8	7
Income Tax recoverable		206	16	6
Cash at Bankers		1,866	4	4
		£144,199	6	8

LADY SLOGGETT'S ROYAL ARMY MEDICAL CORPS COMFORT FUND.

LIST OF DONATIONS RECEIVED DURING 1916.

	£	s.	d.
R.A.M.C.—			
6th Company, Cosham ..	£21	0	0
7th ,, Devonport	45	0	0
13th ,, Edinburgh	2	2	0
14th ,, Dublin ..	5	0	0
14th ,, ,, Serjeants' Mess	3	0	0
17th ,, Curragh ..	5	4	6
19th ,, Chester ..	8	5	0
20th ,, Tidworth ..	10	0	0
25th ,, Bermuda ..	3	3	0
27th ,, Hong Kong	2	0	0
27th ,, ,, Serjeants' Mess	2	0	0
29th ,, Jamaica ..	4	0	0
35th ,, Millbank	50	0	0
35th ,, ,, Serjeants' Mess	5	0	0
Detached Royal Free Hospital	1	3	0
R.A.M.C.—			
Aldershot	300	0	0
Canterbury	2	0	0
Chatham	10	0	0
Cottonera	5	0	0
Malta	24	1	0
Millbank Barracks	30	0	0
Netley	50	0	0
Portobello, Dublin ..	1	10	0
Sheffield	60	0	0
Training Centre, Farnham	50	0	0
,, ,, Ripon ..	25	0	0
Valletta, Malta	12	0	0
Woolwich	5	0	0
Surg.-Gen. and Mrs. Fawcett	16	0	0
Deputy Surg.-Gen. Codington	2	2	0
Surg.-Gen. O'Donnel, C.B. ..	5	0	0
Surg.-Gen. W. Birrell ..	5	0	0
Surg.-Gen. O. E. P. Lloyd, V.C., C.B.	2	0	0
Surg.-Gen. W. H. Burnett ..	1	1	0
Lt.-Col. H. C. E. Hime ..	10	10	0
Lt.-Col. A. Hickman Morgan	5	0	0
Lt.-Col. E. A. Mapleton ..	2	2	0
Lt.-Col. P. Evans, C.M.G. ..	2	0	0
Lt.-Col. C. K. Morgan, C.M.G.	5	0	0
Col. Steuart, per Mrs. Buswell	5	0	0
Col. W. T. Martin	1	1	0
Col. Mould	2	0	0
Col. and Mrs. Nash	4	4	0
Capt. Edgar Grey	5	0	0
Dr. Gillett	0	10	0
N. Connor, Esq., M.D. ..	1	1	0
R. Ramsden, Esq.	3	0	0
W. C. Treacher, Esq., Glasgow	5	0	0
Lady Worthington	3	0	0
Lady Clifford Allbutt	2	2	0
Lady Jekyll	1	0	0
Mrs. Fell	57	0	0
Mrs. Dorman	6	0	0
Mrs. Weir	3	2	0
Mrs. Oppenheimer	17	0	0
Mrs. Delap	8	0	0
Mrs. Ellis	7	2	0
Mrs. Coote	8	3	0
Mrs. Elsie Allan	2	2	0
Mrs. Birrell	5	0	0
Mrs. Treherne	5	0	0
Mrs. Bouswell	2	2	0
Mrs. Archer	1	0	0
Mrs. Brereton	2	2	0
Mrs. Hickman Morgan ..	5	0	0
Mrs. Murray Irwin	5	0	0
Mrs. Geddes	2	2	0
Mrs. Russell	20	0	0
Mrs. Macpherson	23	0	0
Mrs. M. G. Scott	1	0	0
Mrs. Pilcher	0	10	6
Mrs. Russell	0	10	0
Mrs. Laurison Scott	3	3	0
Mrs. McGrigor..	1	0	0
Mrs. Barnet Wilson	2	0	0
Mrs. Hughes	1	1	0
Mrs. Lyon	1	0	0
Mrs. Cordle	0	4	9
Mrs. Bland Jameson	5	0	0
Mrs. Noble	5	10	0
Per Mrs. Irwin :			
Lieut.-Col. W. R. Blackwell	1	0	0
Mrs. W. R. Blackwell ..	1	0	0
Mrs. Lambin	1	0	0
J. Hubbard, Esq.	0	10	0
Per Mrs. A. C. Patterson ..	2	10	0
Per Mrs. Morgan	12	18	4
Per Lady Bruce	10	0	0
Per Mrs. Maker	2	7	0
Per Mrs. Irwin, the Misses Faichnie	1	3	0
Per Mrs. Hobhouse, Brighton	7	12	6
Sister Cuncliffe	2	0	0
Miss Russell	0	7	6
Miss Sexton	0	2	6
Refund Telephone Company	1	0	0
Messrs. Derry and Toms ..	5	0	0
Nursing Staff M.P., Whalley	3	10	0
Bulford Sunday School ..	1	5	0
Greenock Branch R.A.M.C. Comforts	50	0	0
Netley Branch Comfort Funds	15	0	0
Wolverton Prisoners of War Fund	0	10	6
Scottish Branch R.A.M.C. Comforts	70	0	0
Munster Flag Day Fund ..	10	0	0
South Midland M.B.F. Ambulance	5	0	0
Total ..	£1,215	5	1

ROYAL ARMY MEDICAL COLLEGE.

LIST OF BOOKS ADDED TO THE LIBRARY DURING THE MONTHS OF JANUARY, FEBRUARY AND MARCH, 1917.

Title of Work and Author	Edition	Date	How obtained
Squire's Companion to the British Pharmacopœia..	19th	1916	Library Grant.
Medical Diseases of the War. By A. F. Hurst, M.A., M.D.		1917	,, ,,
Clinical Methods. By Hutchison and Rainy ..	6th	1916	,, ,,
Clinical Pathology. By P. N. Panton, M.A., M.B.		1913	,, ,,
Surgical Anatomy. By John A. C. Macewen ..	2nd	1916	,, ,,
Laboratory Studies in Tropical Medicine. By Daniels and Newham	3rd	1911	,, ,,
Collected Papers of the Mayo Clinic. Vol. vii. ..		1915	,, ,,
Diagnosis and Treatment of Surgical Diseases of the Spinal Cord. By Charles A. Elsberg, M.D.		1916	,, ,,
Essentials of Medical Electricity. By Morton and Cumberbatch	3rd	1916	,, ,,
Gray's Anatomy. Edited by R. Howden	19th	1916	,, ,,
Pye's Surgical Handicraft. Edited by W. H. Clayton-Green	7th	1916	,, ,,
Manual of Operative Surgery. By J. F. Binnie ..	7th	1916	,, ,,
The Treatment in Germany of Gunshot Injuries of the Face and Jaws. Translated by W. H. Dolamore		1916	,, ,,
Principles of Diagnosis and Treatment in Heart Affections. By Sir James Mackenzie, M.D., F.R.S.		1916	,, ,,
The Fundus Oculi. By W. Adams Frost, F.R.C.S.		1896	,, ,,
Les Blessures des Nerfs. Par J. Tinel		1916	,, ,,
Military Surgery. By Dunlop P. Penhallow ..		1916	Editor, Journal.
Saint Thomas's Hospital Reports. New Series. Vol. xliii			,, ,,
Die psychischen Schadigungen durch Koppschuss im Kriege 1914-16. Band 1. Von Dr. phil. et Med. Walther Poppelreuter		1917	War Office.
Verhandlungen der Ausserordentlichen Tagung des Deutschen Kongresses für innere Medizin in Warschau am 1 und 2 Mai, 1916. Von W. Hiss und W. Weintraud		1916	,, ,,
The Johns Hopkins Hospital Studies in Typhoid Fever. Nos. 1, 2 and 3. Edited by William Osler, M.D.		1901	,, ,,
Aide-Mémoire du Médecin Militaire Service de Sante en Campagne. Par Le Docteur G. Salle		1900	,, ,,
Climate and Health in Hot Countries. By Lieut.-Col. G. M. Giles, I.M.S.		1904	,, ,,
Mediterranean, Malta or Undulant Fever. By M. Louis Hughes		1897	,, ,,
The Anti-Malaria Measures at Ismailia 1902-04. By Rubert Boyce, F.R.S.		1904	,, ,,
St. Bartholomew's Hospital Reports. Vol. xlix ..		1914	,, ,,
Contributions to Military and State Medicine. Vol. i. By John Martin		1881	,, ,,
The Theory and Practice of Hygiene. By Notter, Firth and Horrocks	2nd	1900	,, ,,
Supplement to War Office Library Catalogue. Parts 1 and 2. Compiled by F. J. Hudleston		1916	,, ,,

LIST OF BOOKS ADDED TO THE LIBRARY—*Continued.*

Title of Work and Author	Edition	Date	How obtained
Nigeria, Annual Report, 1915. Medical Research Institute		1916	Crown Agent for the Colonies.
Local Government Board, Forty-fifth Annual Report. Supplement containing the Report of the Medical Officer for 1915-16		1917	Local Government Board.
Journal of the Royal Naval Medical Service, Vol. iii. No 1.		1917	The Editor.
Report of the Accra Laboratory for the Year 1915. By J. W. Scott MacFie, M.A.		1916	Messrs. Waterlow and Sons, Ltd.
Gangrène Gazeuse pendant la guerre de 1914-1916. Par Prof. Dr. F. Guermonprez		1916	Presented by the Author.
Cerebrospinal Fever in the Royal Navy, August, 1915, to July, 1916. By Temp. Surg.-General H. D. Rolleston, C.B.			,, ,,
An Address on Naval Medicine in the Great War. By Temp. Surg.-General H. D. Rolleston, C.B.		1917	,, ,,
Medical Research Committee. Special Report Series. No. 3. Bacteriological Studies in the Pathology and Preventive Control of Cerebrospinal Fever among the Forces during 1915 and 1916		1917	Presented by Lieut.-Col. M. H. Gordon. R.A.M.C.
Commonwealth of Australia. Department of Trade and Customs. Committee concerning Causes of Death and Invalidity in the Commonwealth. Report on Tuberculosis		1916	Presented by the Chairman of the Committee.
Proceedings of the 3rd Army Corps Medical Society, British Expeditionary Force (Manuscript)		1915-16	Presented by Major M. B. H. Ritchie, D.S.O., R.A.M.C.

PRELIMINARY TRAINING FOR PROSPECTIVE OFFICERS OF THE AIR SERVICES.

WITH a view to affording to young men below the age of 18 a preliminary training which would give them some sound technical qualification when applying for commissions in the Air Services, either as a cadet or not, the Aeronautical Institute has decided to follow, in this respect, the example already set by the French educational authorities, who have recently started preliminary aeronautical courses at the Sorbonne under M. Marchis, the eminent Professor of Aviation of the University of Paris and a Member of the Aeronautical Institute's Advisory Council.

The Preliminary Course of the Aeronautical Institute will be very practical in character, and will cover a working knowledge of aviation motors, of the function and construction of the various parts of the aeroplane concerned with its sustentation, propulsion and evolution both in flight and on the ground.

Those following the course, which will last about three months, and which will entail a full-day attendance five days a week, will be afforded workshop and drawing office practice as well as a sound practical knowledge of the materials used in aircraft construction, and particular attention will be paid to points connected with the upkeep of machines.

The theoretical portion of the course, which, as far as possible, will be illustrated by actual full-sized aeroplanes or parts of them, will entail no more mathematical knowledge than is usually expected from an average youth of 17 or 18.

The Institute's course, exactly like the Sorbonne's, will be independent of any other organization, whether governmental or not; and, again, like the latter, will not be a guarantee that any of its students, after going through the course satisfactorily, will necessarily be granted commissions in the Air Services, for the granting of such commissions must, of course, only rest with the military and naval authorities who have to consider the qualifications of applicants as a whole. But it is obvious that, other things being equal, applicants for commissions in the Air Services must, if they possess a sound preliminary knowledge of aircraft, stand a far better chance than those having no such training.

The Institute hopes that by providing the preliminary knowledge outlined above it will be able to help the Flying Services either to train their officers much more rapidly than at present, or, if their period of official training is not reduced, to still further increase their degree of efficiency.

Full particulars of the course can be obtained from the Hon. Secretary of the Aeronautical Institute, 3, Arlington Street, London, S.W. 1.

SURGEON-GENERAL SIR WILLIAM TAYLOR, K.C.B., M.D., K.H.P., LL.D.

(AN APPRECIATION.)

The career of the late Sir William Taylor, whose death took place somewhat suddenly last month, calls for more than a passing notice. He possessed two attributes which always stood him in good stead—one was his admirable professional attainments (he had been a pupil of Lister and dogged his footsteps wherever that distinguished man migrated), and the other his inexhaustible physical energy. Commencing his Army career in 1864, his first foreign service was in Canada, where he came under the immediate notice of Sir William Muir, Principal Medical Officer of the Forces in that country, later he was appointed Assistant-Surgeon to a troop of Royal Horse Artillery stationed at Peshawar, and on promotion was transferred to medical charge of Mount Abu in the Central Provinces. When Sir F. Roberts became Commander-in-Chief in 1885, he nominated Taylor to his personal staff; they were a happy family, carefully chosen; almost all of them have since risen to distinction—occupying the highest posts in the Army, and amongst them there was no more popular member than "Billy" Taylor, as he was always affectionately called.

His next appointment was that of Secretary to the Principal Medical Officer of His Majesty's Forces in India, at that time Surgeon-General Thomson; they were an ideal combination and their firm but sympathetic regime will long be gratefully remembered by the officers of both Services.

On return to England in 1892, he took up a subordinate post in the War Office, but when War broke out between China and Japan in 1894 he was—at the instance of Sir Redvers Buller, at that time Adjutant-General—selected to proceed to the seat of War in order to study the medical service of the Japanese Field Army; he was immensely struck with the organization of that Army in all its branches, and his judgment was amply confirmed by subsequent events in 1904-5.

On his return to England in the Autumn of 1895, he was appointed to Dover, but was not allowed to rest long: the Ashanti Campaign was impending and Sir William Mackinnon—at that time Director-General—nominated Taylor as Principal Medical Officer. There was no fighting and—thanks to the admirable medical arrangements, but little sickness: the result, as far as Taylor was concerned, was to secure him special promotion to the rank of Surgeon-General. He then re-entered the War Office in a higher appointment, where he remained until the Nile Expedition of 1898, when he joined General Kitchener just prior to the advance on Khartoum, and it may be noted that the two men, so dissimilar in many respects, had one taste in common in that they were both passionately fond of gardening. Having successfully organized the River transport for the evacuation of the wounded after Omdurman, Taylor—who was about the last to leave—returned to England, where he spent a couple of months prior to proceeding to India to take up the post of Principal Medical Officer in that country. Here he spent three years, thereby missing the South African War, but he

did good work at Simla in despatching admirably equipped medical units both to Natal and North China.

On the re-organization of the Army Medical Service, as the result of the Broderick Committee, Taylor was brought home at the end of 1901 to take up the appointment of Director-General, which he held for the authorized term of three years.

When the present War broke out—although over 70 years of age—he felt he could not be idle and, offering his services, was appointed to the charge of the Princess Christian Red Cross Hospital, Englefield Green, which under his supervision became a model of its kind, and where many of our wounded heroes have been nursed back to health. He had latterly been subject to laryngeal attacks, and as a result of exposure during one of the March blizzards, he developed acute bronchitis, which terminated fatally on the 10th ult. In recognition of his distinguished services—which covered six campaigns in various parts of the world—he was accorded a military funeral and was buried at Windsor on Saturday, the 14th idem, in the presence of numerous friends and old brother officers.

We cannot conclude this notice without referring to Sir William Taylor in two capacities—as a sportsman and as a man of business. In the former as First Whip and, subsequently Master of the Peshawar Vale Hounds in the seventies, he showed excellent sport and was a daring horseman—hard as nails—which stood him in good stead when he joined the Commander-in-Chief on those long and historic rides along the North-West Frontier; he was also fond of polo, but never became a first-class player.

As a *business* man three instances will suffice. When in the late eighties the United Service Club at Simla fell on evil days and a rival establishment had sprung up, Taylor took up the duties of Hon. Secretary, and with Sir George Chesney, as Chairman, to back him, by sheer hard work out of office hours, combined with a broad and liberal-minded policy, he soon placed that institution on a solid foundation and its prosperity has ever since been maintained; whilst to show their appreciation the members had the portraits of both these officers painted, and these now adorn the Club walls.

On return from Ashanti in 1896 he took a leading part in conjunction with Lord Wantage, Sir John Furley and others in the formation of the Army Nursing Reserve, of which H.R.H. Princess Christian is President, and whose members—expanded far beyond the original conception—did such splendid work in the South African War.

Lastly, as Vice-Chairman of the Committee of the Royal School for Officers' Daughters, Bath, which post he took up some three years ago, by *personally* addressing and interesting the past pupils of that great College, he succeeded in enlisting their help and sympathy, which has since been shown in a very practical manner.

A kind and courteous gentleman, Sir William Taylor's bright and genial personality will ever be fondly remembered by his numerous friends and acquaintances in all parts of the British dominions.

BIRTHS.

PROBYN.—On March 27, 1917, at Hyde Terrace Nursing Home, Leeds, to Lieut.-Col. P. J. Probyn, D.S.O., R.A.M.C., and Mrs. Percy Probyn, a daughter (Phyllis Pinnell).

ALLNUTT.—On April 26, at Woodside, Hitchin, Herts, to the wife of Capt. E. B. Allnutt, M.C., R.A.M.C., a son.

MARRIAGE.

CRAWFORD—JACKSON.—On April 17, 1917, at the Parish Church, Clones, by the Rev. Canon Ruddell, Lieut.-Col. Vincent J. Crawford, D.S.O., R.A.M.C., third son of the late Sir Thomas Crawford, K.C.B., A.M.S., to Eileen Kathleen, elder daughter of the late Samuel Kidd Jackson and of Mrs. Jackson, Carn Clones, Co. Monaghan.

DEATH.

AUSTIN.—On the 26th inst., at a Military Hospital in London, Col. John Henry Edward Austin, A.M.S., son of the late Rev. Edward Austin, Rendlesham, Suffolk.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Oheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints			
				As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	5 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

* These are not arranged as Reprints, but appear precisely as in the Journal with any other matter that may happen to appear on the first and last pages of the particular excerpt ordered.

Cases for Binding Volumes.—Strong and useful cases for binding can be obtained from the publishers at the undermentioned rates:—

Covers, 1s. 8d. net; binding, 1s. 6d.

These charges are exclusive of cost of postage.

In forwarding parts for binding the name and address of sender should be enclosed in parcel.

The above figures are subject to 15 per cent. increase.

Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Lieutenant Colonel G. Chambers; Captains A. Compton, H. G. Gibson, D. B. McGrigor, W. L. Christie, A. R. Robertson, A. G. Fleming, J. C. Calhoun, R. George, H. C. Semon, E. D. Adrian, D. Thomson; Lieutenant A. F. MacCulloch; E. F. Syrett, Esq., H. M. Woodcock, Esq.

The following publications have been received:—

British: Public Health, St. Bartholomew's Hospital Journal, The Medical Press and Circular, The Hospital, The British Journal of Tuberculosis, The Medical Review, The Journal of State Medicine, The Indian Journal of Medical Research, Agricultural Research Institute, Pusa, The Indian Medical Gazette, The Lancet, British Medical Journal, Proceedings of the Royal Society of Medicine, The Medical Journal of Australia, The Medical Journal of South Africa, Guy's Hospital Gazette, The Army Service Corps Journal, The Practitioner, Journal of the Royal Naval Medical Service, Tropical Diseases Bulletin, The Royal Engineers' Journal, Transactions of the Society of Tropical Medicine and Hygiene, The British Journal of Surgery, The Journal of Tropical Medicine and Hygiene, Journal of the United Service Institution of India.

Foreign: Archives Médicales Belges, Giornale Medecina di Militar, The Military Surgeon, United States Public Health Service, Envoi de l'Office International d'Hygiène Publique, Revue de Chimiothérapie, Bulletin de l'Institut Pasteur, Norsk Tidsskrift for Militarmedicin, Russian Naval Medical Journal, Archives de Médecine et Pharmacie Navales, United States Department of Agriculture, Archives de Médecine et de Pharmacie Militaires, Le Caducée, The Philippine Journal of Science, Bulletin of the Johns Hopkins Hospital, The Military Surgeon, Bulletin de la Société de Pathologie Exotique, United States Naval Medical Bulletin.

MANAGER'S NOTICES.

The **Journal of the Royal Army Medical Corps** is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

The Hon. Manager,
"Journal of the Royal Army Medical Corps,"
War Office, Whitehall, S.W.

JOURNAL

OF THE

ROYAL ARMY MEDICAL CORPS.

Corps News.

JUNE, 1917.

APPOINTMENTS, COMMISSIONS, REWARDS, &c.

Approved by the Lieutenant-General Commanding-in-Chief, British Salonika Force.
(Subject to War Office approval where authority is not quoted.)

LIST No. 45.

General Headquarters,
British Salonika Force.
March 30, 1917.

HONOURS AND REWARDS.

Under authority granted by His Majesty the King to the Lieutenant-General Commanding-in-Chief, the following honours have been awarded for gallantry and devotion to duty in the Field, dated March 12, 1917 :—

Military Medal.

No. 36355 Cpl. (Acting-Serjt.) Henry Ullyatt, Royal Army Medical Corps.
No. 34844 Serjt. Ralph William Nicol, Royal Army Medical Corps.
No. 62873 Pte. (Acting-Cpl.) Charles Binion, Royal Army Medical Corps.
No. 31278 Pte. Patrick Oxford, Royal Army Medical Corps.
No. 63251 Pte. Arthur Edward Craven, Royal Army Medical Corps.
No. 70709 Pte. Drever Poyntz Bush, Royal Army Medical Corps.

Meritorious Service Medal.

No. 11027 Serjt.-Major John Henry Masters, Royal Army Medical Corps.
No. 16573 Serjt.-Major Robert Stewart Nichol, Royal Army Medical Corps.
No. 11952 Qmr.-Serjt. (Acting-Serjt.-Major) Albert Edward Malley, Royal Army Medical Corps.
No. 17910 Serjt. (Acting-Qrmr.-Serjt.) Walter Green, Royal Army Medical Corps.
No. 57424 Serjt. Frank Algernon Wood, Royal Army Medical Corps.

GRANARD, *Lieutenant-Colonel,*
Assistant Military Secretary to the Commander-in-Chief, British Salonika Force.

EXTRACTS FROM THE "LONDON GAZETTE."

May 4, 1917.

THE GRAND PRIORY OF THE ORDER OF THE HOSPITAL OF ST. JOHN OF JERUSALEM IN ENGLAND.

May 3, 1917.

The King has been graciously pleased to sanction the following promotions in and appointments to the Order of the Hospital of St. John of Jerusalem in England :—

As Knights of Grace.

Major Sir Edward Scott Worthington, C.M.G., M.V.O., M.D. (from Esquire).
Lieut. Col. Frank Warburton Begbie, M.R.C.S., L.R.C.P., R.A.M.C. (from Honorary Associate).

War Office,
May 11, 1917.

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officer in recognition of his gallantry and devotion to duty in the Field:—

Capt. Stanley Sextus Barrymore Harrison, Royal Army Medical Corps, attached South Staffordshire Regiment.

For conspicuous gallantry and devotion to duty. He worked continuously for ten hours under very heavy fire and was responsible for saving many lives. He displayed great courage and determination throughout. He has on many previous occasions done fine work.

His Majesty the King has been graciously pleased to confer the Military Medal for Bravery in the Field to the undermentioned Lady, Non-commissioned Officers and Men:—

Staff Nurse Miss Daisy Ellen Dobbs, Nursing Service.
No. 1878 Pte. G. W. Bonner, Royal Army Medical Corps.
No. 1927 Serjt. W. J. Etheridge, Royal Army Medical Corps.
No. 37749 Pte. (Acting-Serjt.), G. Gordon, Royal Army Medical Corps.
No. 1978 Serjt. F. J. Henwood, Royal Army Medical Corps.
No. 4969 Pte. J. Oldham, Royal Army Medical Corps, attached Royal Field Artillery.
No. 34245 Pte. (Cpl.) J. Slater, Royal Army Medical Corps.

War Office,
May 15, 1917.

The following formed part of the Russian Decorations awarded in July, 1916, to the British Forces for distinguished services rendered during the course of the campaign:—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

General Headquarters, Indian Expeditionary Force "D."
December 22, 1916.

The Order of St. George, 4th Class.

Capt. John Alexander Sinton, V.C., Indian Medical Service.

The Order of St. Anne, 2nd Class (with Swords).

Lieut.-Col. and Brevet-Col. John Macfarlane Sloan, D.S.O., M.B., Royal Army Medical Corps.

The Order of St. Stanislas, 2nd Class (with Swords).

Lieut.-Col. and Brevet-Col. Matthew Henry Gregson Fell, Royal Army Medical Corps.

The Cross of St. George, 2nd Class.

No. 1105 Sub-Assistant-Surgeon Karta Ram, Indian Subordinate Medical Department.

The Cross of St. George, 4th Class.

3rd Class Assistant-Surgeon Gerald Hugh Blaker, Indian Subordinate Medical Department.
No. 31063 Staff-Serjt. David Brown, Royal Army Medical Corps.
2nd Class Assistant-Surgeon Eugene Avron Cotton, Indian Subordinate Medical Department.

The Medal of St. George, 4th Class.

No. 27344 Pte. William Hodson, Royal Army Medical Corps.

War Office,
May 26, 1917.

The following are among the Decorations and Medals awarded by the Allied Powers at various dates to the British Forces for distinguished services rendered during the course of the campaign:—

His Majesty the King has given unrestricted permission in all cases to wear the Decorations and Medals in question.

DECORATIONS AND MEDALS CONFERRED BY HIS MAJESTY THE KING OF ITALY.

Cavalier.

Lieut.-Col. William Weston **Hearne**, Australian Army Medical Corps.

The Order of the Crown of Italy.

Commander.

Surg.-Gen. William Grant Macpherson, C.B., C.M.G., M.B., K.H.P.

The Silver Medal for Military Valour.

Capt. Howard Hampton Burnham, Canadian Army Medical Corps.
Temp. Capt. Hugh Noel Murray Puckle, M.B., Royal Army Medical Corps.
Temp. Capt. Maitland Scott, Royal Army Medical Corps.
Temp. Capt. Charles McMoran Wilson, M.C., M.D., Royal Army Medical Corps.

The Bronze Medal for Military Valour.

No. 1891 Cpl. John Edward Aldridge, Royal Army Medical Corps.
No. 2035 Serjt. Henry Howard Boland, Royal Army Medical Corps,
No. 2693 Pte. John Duggan, Royal Army Medical Corps.
No. 65867 Pte. Herbert Everall, Royal Army Medical Corps.
No. 40988 Staff-Serjt. Robert Stewart Gillespie, Royal Army Medical Corps.
No. 48798 Serjt. Thomas Mordecai Jones, Royal Army Medical Corps.
No. 38791 Pte. Martin Thornton, Royal Army Medical Corps.
No. 45926 Pte. Frederick Whitwood, Royal Army Medical Corps.

War Office,
May 26, 1917.

His Majesty the King has been graciously pleased to award a Bar to the Military Cross to the undermentioned Officer:—

Temp. Capt. Reginald Peter Nutcombe Buckland Bluett, M.C., Royal Army Medical Corps, attached Highland Light Infantry.

For conspicuous gallantry and devotion to duty. He displayed great judgment and endurance in organizing the stretcher-bearers in the attack. He worked continuously throughout the day, exposed for many hours to very heavy hostile fire. (M.C. gazetted March 30, 1916.)

His Majesty the King has been graciously pleased to confer the Military Cross on the undermentioned Officers in recognition of their gallantry and devotion to duty in the Field:—

Temp. Capt. Thomas Dowzer, F.R.C.S.I., Royal Army Medical Corps, attached Manchester Regiment.

For conspicuous gallantry and devotion to duty. He showed great personal bravery in moving about in the open under heavy fire, organizing his bearers, and assisting in the search for the wounded.

Capt. Thomas Graham, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He rendered invaluable assistance in evacuating the wounded under very heavy fire. He has at all times set a splendid example of courage and determination.

Capt. Thomas Whittle Martin, M.B., Royal Army Medical Corps, Special Reserve, attached Royal Scots.

For conspicuous gallantry and devotion to duty. He was of the greatest assistance in organizing the evacuation of the wounded across "No Man's Land" during the operation. He has on many previous occasions done fine work.

Temp. Capt. Francis Lorne McKinnon, M.D., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. He personally led a search party up to the enemy wire in front of the village, under very close rifle and machine-gun fire. He succeeded in recovering two wounded men.

Temp. Capt. Charles O'Brien, M.B., Royal Army Medical Corps.

For conspicuous gallantry and devotion to duty. Although wounded, he insisted on remaining in command of the bearer division of his field ambulance, and in so doing materially expedited the removal of the wounded from the field.

Capt. Bertrand Cecil Owens Sheridan, M.B., Royal Army Medical Corps, Special Reserve, attached Worcester Regiment.

For conspicuous gallantry and devotion to duty. He tended the wounded continuously for twelve hours under very heavy fire. He set a splendid example of courage and determination throughout.

Australian Imperial Force.

Capt. George Charles Willcocks, Australian Army Medical Corps.
For conspicuous gallantry and devotion to duty. He worked continuously for about sixteen hours in the open under heavy fire, and successfully evacuated a large number of wounded men. He set a splendid example of courage and determination.

South African Force.

Capt. Francis Heygate Ellis, M.O., Rhodesian R.
For conspicuous gallantry and devotion to duty on many occasions. He has at all times displayed total disregard of personal safety, and has set a fine example to all ranks.

His Majesty the King has been graciously pleased to award the Military Medal for bravery in the Field to the undermentioned Ladies, Non-Commissioned Officers and Men :—

Staff Nurse A. R. Colhoun, Queen Alexandra's Imperial Military Nursing Service Reserve.
Staff Nurse E. Garrett, Queen Alexandra's Imperial Military Nursing Service Reserve.
No. 339298 Staff-Serjt. W. Brooke, Royal Army Medical Corps.
No. 81193 Pte. M. R. Draper, Royal Army Medical Corps, attached Royal Garrison Artillery.
No. 1974 Serjt. C. D. Ferguson, Royal Army Medical Corps.
No. 61886 Serjt. R. H. Foster, Royal Army Medical Corps.
No. 61051 Pte. (Acting Serjt.) H. J. Harris, Royal Army Medical Corps.
No. 5469 Cpl. (Acting Serjt.) G. H. Jordan, Royal Army Medical Corps, attached York Light Infantry.
No. 66400 Pte. G. Payne, Royal Army Medical Corps.
No. 88070 Pte. S. J. Schofield, Royal Army Medical Corps.
No. 62191 Pte. T. Walpole, Royal Army Medical Corps.

His Majesty the King has been graciously pleased to award the Meritorious Service Medal to the undermentioned Warrant Officer and Non-commissioned Officers in recognition of valuable services rendered with the Armies in the Field during the present war :—

No. 320134 Serjt. J. Lamont, Royal Army Medical Corps (formerly 1830).
No. 541046 Serjt. W. A. Piggott, Royal Army Medical Corps.
No. 17022 Staff-Serjt. (Acting Serjt.-Major) A. R. Weaver, Royal Army Medical Corps.

Central Chancery of the Orders of Knighthood.

Lord Chamberlain's Office,
St. James's Palace, S.W.,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to give orders for the following appointment to the Most Honourable Order of the Bath :—

To be Ordinary Member of the Military Division of the Third Class, or Companion, of the said Most Honourable Order :—

Lieut.-Col. Charles Arthur Johnston, D.S.O., M.B., Indian Medical Service.

Central Chancery of the Orders of Knighthood.

Lord Chamberlain's Office,
St. James's Palace, S.W.,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to give orders for the following promotions in, and appointments to, the Most Honourable Order of the Bath, for valuable services rendered in connexion with Military Operations in the Field :—

To be Additional Members of the Military Division of the Third Class, or Companions, of the said Most Honourable Order :—

Col. Roger Kirkpatrick, C.M.G., M.D., Army Medical Service.
Col. Charles Henry Burtchaell, C.M.G., M.B., Army Medical Service.
Col. John Joseph Gerrard, M.B., Army Medical Service.
Temp. Col. William Henry Willcox, C.M.G., M.D., F.R.C.P.

Lieut.-Col. (Temp. Col.) George Washington Brazier-Creagh, C.M.G. (retired pay), late Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Hugh Stanley Thurston, C.M.G., Royal Army Medical Corps.

CENTRAL CHANCERY OF THE ORDERS OF KNIGHTHOOD.

Lord Chamberlain's Office,
St. James's Palace, S.W.,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to give orders for the following promotions in, and appointments to, the Most Honourable Order of the Bath, for services rendered in connexion with the war:—

To be Additional Members of the Military Division of the Second Class, or Knights Commanders, of the said Most Honourable Order:—

Col. James Magill, C.B., M.D. (retired pay).

Lieut.-Col. Peter Johnston Freyer, C.B., M.D., Indian Medical Service (retired).

To be Additional Members of the Military Division of the Third Class, or Companions, of the said Most Honourable Order:—

Lieut.-Col. and Brevet-Col. Sir Bruce Gordon Seton, Bt., Indian Medical Service.

Col. Douglas Wardrop, C.V.O., M.B. (retired pay), Army Medical Service.

Col. Charles Robert Tyrrell (retired pay), Army Medical Service.

Temp. Col. James Galloway, M.D., F.R.C.P., F.R.C.S., Army Medical Service.

Surg. Lieut.-Col. Sir Warren-Roland Crook-Lawless, C.I.E., M.D. (retired pay), Reserve of Officers (employed Royal Army Medical Corps).

Surg. Lieut.-Col. (Hon. Surg.-Col.) Richard James Reece, M.D., Honourable Artillery Company.

CHANCERY OF THE ORDER OF SAINT MICHAEL AND SAINT GEORGE.

Downing Street,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to give directions for the following promotions in, and appointments to, the Most Distinguished Order of Saint Michael and Saint George, for services rendered in connexion with Military Operations in the Field:—

To be Additional Members of the Second Class, or Knights Commanders, of the said Most Distinguished Order:—

Surg.-Gen. Sir Arthur Thomas Slogget, K.C.B., C.M.G., K.H.S.

Surg.-Gen. Francis Harper Treherne, C.M.G.

Surg.-Gen. Tom Percy Woodhouse, C.B.

To be Additional Members of the Third Class, or to be Companions, of the said Most Distinguished Order:—

Col. Courtenay Clarke Manifold, C.B., M.B., Indian Medical Service.

Col. Denis Moriarty O'Callaghan, Army Medical Service.

Col. Alfred William Bewley, Army Medical Service.

Lieut.-Col. (Temp. Col.) Frederick James Greig (retired pay), Reserve of Officers, late Royal Army Medical Corps.

Lieut.-Col. George Scott, M.B. (retired pay), late Royal Army Medical Corps.

Lieut.-Col. Andrew Hosie, M.D. (retired pay), late Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) John Colpoys Connor, M.B., Royal Army Medical Corps.

Temp. Lieut.-Col. Arthur Dawson Milne, M.B., East African Medical Service.

Major (Temp. Lieut.-Col.) Richard James Campbell Thompson, D.S.O., Royal Army Medical Corps.

Australian Forces.

Col. Reuter Emerick Roth, D.S.O., Army Medical Corps

CHANCERY OF THE ORDER OF SAINT MICHAEL AND SAINT GEORGE.

Downing Street,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to give directions for the following promotions in, and appointments to, the Most Distinguished Order of Saint Michael and Saint George, in recognition of valuable services in connexion with the war:—

To be Additional Member of the Second Class, or Knight Commanders, of the said Most Distinguished Order :—

Col. Robert Neil Campbell, C.B., C.I.E. (retired), Indian Medical Service.

To be Additional Members of the Third Class, or to be Companions, of the said Most Distinguished Order :—

Lieut.-Col. Terence Humphrys Sweeny, F.R.C.S.I. (retired), Indian Medical Service.

Lieut.-Col. Francis Frederick Perry, C.I.E., F.R.C.S. (retired), Indian Medical Service.

Lieut.-Col. Joshua Chaytor-White, M.D. (retired), Indian Medical Service.

Lieut.-Col. Sidney Browning Smith, Indian Medical Service.

Lieut.-Col. John Norman MacLeod, C.I.E., M.B., F.R.C.S. (retired), Indian Medical Service.

Lieut.-Col. David Harvey, M.D., Royal Army Medical Corps.

Temp. Hon. Lieut.-Col. Mervyn Henry Gordon, M.D., Royal Army Medical Corps.

Major Patrick Stanislaus O'Reilly, Royal Army Medical Corps.

Major George Alfred Duncan Harvey, Royal Army Medical Corps.

Temp. Major Archibald Douglas Reid, Royal Army Medical Corps.

Australian Forces.

Col. Reginald Jeffrey Millard, Australian Army Medical Corps.

Lieut.-Col. William Thornborough Hayward, Australian Army Medical Corps.

Lieut.-Col. Thomas Ernest Victor Hurley, Australian Army Medical Corps.

Canadian Forces.

Col. Charles Alfred Hodgetts, Canadian Army Medical Corps.

India Office,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to make the following promotions in, and appointments to, the Most Eminent Order of the Indian Empire :—

To be Companions of the said Most Eminent Order :—

Lieut.-Col. David Waters Sutherland, M.D., M.R.C.P., F.R.S., Indian Medical Service, Principal, Medical College and School, Lahore, Punjab.

Lieut.-Col. John Anderson, M.B., Indian Medical Service (retired), Member of Medical Board at the India Office.

India Office,
June 4, 1917.

The King has been graciously pleased, on the occasion of His Majesty's Birthday, to make the following promotion in, and appointment to, the Most Eminent Order of the Indian Empire, in recognition of the meritorious service of the undermentioned gentleman in connexion with the War :—

TO BE ADDITIONAL COMPANION OF THE SAID MOST EMINENT ORDER.

Capt. Harold Hay Thorburn, Indian Medical Service, serving with the South Persia Rifles, Shiraz.

War Office,
June 4, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for distinguished service in the Field, dated June 3, 1917 :—

TO BE SURGEON-GENERAL.

Col. (Temp. Surg.-Gen.) W. W. Pike, C.M.G., D.S.O., F.R.C.S.I.

TO BE BREVET COLONELS.

Lieut.-Col. S. L. Cummins, C.M.G., M.D., Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) G. T. K. Maurice, C.M.G., Royal Army Medical Corps.

TO BE BREVET LIEUTENANT-COLONEL.

Major P. H. Henderson, D.S.O., M.B., Royal Army Medical Corps.

TO BE BREVET MAJORS.

Capt. D. M. Corbett, M.B., Royal Army Medical Corps.

Capt. (Acting-Lieut.-Col.) B. Johnson, M.B., Royal Army Medical Corps.

Capt. H. F. Panton, M.C., M.B., Royal Army Medical Corps.

TO BE HONORARY LIEUTENANT-COLONEL.

Qmr. and Hon. Major J. B. Short, Royal Army Medical Corps.

TO BE HONORARY MAJOR.

Qmr. and Hon. Capt. E. J. Buckley, Royal Army Medical Corps.

TO BE GRANTED THE NEXT HIGHER RATE OF PAY UNDER THE PROVISIONS OF THE ROYAL WARRANT FOR PAY.

Qmr. and Hon. Lieut. H. W. Rose, Royal Army Medical Corps.

War Office,
June 4, 1917.

His Majesty the King has been graciously pleased to approve of the undermentioned rewards for Distinguished Service in the Field :—

TO BE COMPANIONS OF THE DISTINGUISHED SERVICE ORDER.

Major (Temp. Lieut.-Col.) David Ahern, Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) John Donald Alexander, M.B., Royal Army Medical Corps.
Temp. Capt. Philip Henry Bahr, M.D., Royal Army Medical Corps.
Lieut.-Col. Harold John Kinahan Bamfield, Indian Medical Service.
Lieut.-Col. (Temp. Col.) Arthur Winhiett Nunn Bowen, Royal Army Medical Corps.
Major Roland Harley Bridges, Royal Army Medical Corps.
Capt. Francis Casement, M.B., Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) Henry King Dawson, M.D., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Benjamin Howard Vella Dunbar, M.D., Royal Army Medical Corps.
Temp. Capt. James Jameson Dwyer, Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) Philip Gordon Moss Elvery, M.C., Royal Army Medical Corps.
Lieut.-Col. Harold Benn Fawcus, C.M.G., M.B., Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) Alexander Donald Fraser, M.C., M.B., Royal Army Medical Corps.
Major George Ernest Gask, F.R.C.S., L.R.C.P., Royal Army Medical Corps.
Lieut.-Col. (Acting Col.) James Geoffrey Gill, Royal Army Medical Corps.
Lieut.-Col. Gerald Hamilton Goddard, Royal Army Medical Corps.
Capt. John Golding, Royal Army Medical Corps.
Temp. Major (Temp. Lieut.-Col.) Edward Lake Gowlland, M.B., Royal Army Medical Corps (late Major R.G.A., T.F.).
Major (Temp. Lieut.-Col.) George Herbert Leonard Hammerton, Royal Army Medical Corps.
Major Edward Temple Harris, M.B., Indian Medical Service.
Lieut.-Col. (Acting Col.) Henry Herrick, Royal Army Medical Corps.
Second Lieut. (Temp. Capt.) Marcus Beresford Heywood, M.B., Yeomanry.
Major (Temp. Lieut.-Col.) Harold Crossley Hildreth, F.R.C.S., Royal Army Medical Corps.
Lieut.-Col. Cyril Henry Howkins, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) William Davenport Crawley Kelly, Royal Army Medical Corps.
Capt. Hyman Lightstone, M.C., Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) Archibald Smith Littlejohns, Royal Army Medical Corps.
Temp. Lieut.-Col. David Dale Logan, M.D., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Peter MacKessack, M.B., Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) George Mackie, Royal Army Medical Corps.
Capt. (Acting Lieut.-Col.) Robert Magill, M.B., Royal Army Medical Corps, Special Reserve.
Temp. Capt. John Richardson Marrack, M.C., M.B., Royal Army Medical Corps.
Lieut.-Col. Edwin Walter Purdy Vere Marriott, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) John Matthews, Royal Army Medical Corps.
Capt. (Acting.Lieut.-Col.) Charles Reade Monroe Morris, M.B., Royal Army Medical Corps.
Capt. (Acting-Lieut.-Col.) Kenneth Duncan Murchison, M.B., Royal Army Medical Corps, Special Reserve.
Capt. (Acting-Lieut.-Col.) Arthur Drought O'Carroll, M.B., Royal Army Medical Corps.

Lieut.-Col. (Temp. Col.) Standish de Courcy O'Grady, M.B., Royal Army Medical Corps.
Major James Sidney Pascoe, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) John Edward Powell, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Thomas Phare Puddicombe, M.B., Royal Army Medical Corps.
Lieut.-Col. (Temp. Col.) Malcolm MacGregor Rattray, M.B., Royal Army Medical Corps.
Major John Duncan Richmond, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Henry Rogers, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) David Rorie, M.D., Royal Army Medical Corps.
Temp. Capt. (Acting-Lieut.-Col.) Lawrence Drew Shaw, Royal Army Medical Corps.
Major George Faber Sheehan, Royal Army Medical Corps.
Major Samuel Boylan Smith, M.D., Royal Army Medical Corps.
Capt. (Acting-Lieut.-Col.) Gerald Hoey Stevenson, M.B., Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Hugh Stewart, M.C., M.B., Royal Army Medical Corps.
Capt. (Acting-Lieut. Col.) Murray Ross Taylor, M.D., Royal Army Medical Corps, Special Reserve.
Capt. (Temp. Major) Richard Stopford Taylor, M.B., F.R.C.S., Royal Army Medical Corps.
Capt. Arnold Newall Thomas, M.B., Indian Medical Service.
Major John Archbold Turnbull, Royal Army Medical Corps.
Temp. Capt. Robert Bruce Wallace, M.B., Royal Army Medical Corps.
Lieut.-Col. Anthony Henry Waring, Royal Army Medical Corps.
Major Charles Henry Watson, Indian Medical Service.
Capt. (Acting-Lieut-Col.) Alan Geoffery Wells, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Richard Melbourne West, M.D., Royal Army Medical Corps.
Major Walter John Weston, Royal Army Medical Corps.
Lieut.-Col. Edwin Arnold Wraith, Royal Army Medical Corps.
Major (Temp. Lieut.-Col.) Thomas James Wright, Royal Army Medical Corps.

Australian Force.

Lieut.-Col. Harry Nairn Butler, Australian Army Medical Corps.
Major George Cumming Byrne, Australian Army Medical Corps.
Major George Edwards Cole, Australian Army Medical Corps.
Lieut.-Col. (Temp. Col.) Constantine Trent Champion de Crespigny, Australian Army Medical Corps.
Major William Angus Fraser, Australian Army Medical Corps.
Lieut.-Col. (Temp. Col.) William Weston Hearne, Australian Army Medical Corps.
Lieut.-Col. (Temp. Col.) Robert Beveridge Huxtable, Australian Army Medical Corps.
Major Cyril Leslie Stewart Mackintosh, Australian Army Medical Corps.
Captain Arthur Hunter Powell, Australian Army Medical Corps.
Lieut.-Col. Arthur Hamilton Tebbutt, Australian Army Medical Corps.
Major Roy William Whiston Walsh, Australian Army Medical Corps.
Major Herbert Locksley St. Vincent Welch, Australian Army Medical Corps.

Canadian Force.

Lieut.-Col. William Belfry Hendry, Canadian Army Medical Corps.
Major John Stephen Jenkins, Canadian Army Medical Corps.
Lieut.-Col. Chester Fish McGuffen, Canadian Army Medical Corps.
Lieut.-Col. John Douglas McQueen, Canadian Army Medical Corps..
Lieut.-Col. Charles Perry Templeton, Canadian Army Medical Corps.
Lieut.-Col. Edward Johnston Williams, Canadian Army Medical Corps.

New Zealand Force.

Major Thomas Duncan MacGregor Stout, New Zealand Medical Corps.

South African Contingent.

Lieut.-Col. Robert Laurie Girdwood, South African Medical Corps.
Major (Acting-Lieut.-Col.) Robert Norman Pringle, South African Medical Corps.
Lieut.-Col. Herbert Wynne Vaughan-Williams, South African Medical Corps.

AWARDED THE MILITARY CROSS.

Temp. Capt. George Oliver Fairtlough Alley, M.B., Royal Army Medical Corps.
Capt. Leonard Barron Baird, Royal Army Medical Corps.

Capt. Joseph Herbert Bayley, Royal Army Medical Corps, Special Reserve.
Temp. Capt. John Howard Box, M.B., Royal Army Medical Corps.
Capt. Ralph Alexander Broderick, Royal Army Medical Corps.
Temp. Capt. John Vassie Brown, M.B., Royal Army Medical Corps.
Temp. Capt. Leonard Graham Brown, Royal Army Medical Corps.
Capt. Arthur Edwin Bullock, M.B., Royal Army Medical Corps.
Temp. Capt. Edward Robert Cecil Cooke, Royal Army Medical Corps.
Capt. Joseph Mary Aloysius Costello, M.B., Royal Army Medical Corps.
Capt. George Dalziel, M.B., Royal Army Medical Corps, Special Reserve.
Capt. Arthur Norman Dickson, M.D., Indian Medical Service.
Lieut. Robert Ellis, M.B., Royal Army Medical Corps, Special Reserve.
Capt. William Tyler Gardiner, M.B., F.R.C.S., Royal Army Medical Corps..
Temp. Capt. Noel John Hay Gavin, M.B., Royal Army Medical Corps.
Capt. William George, M.B., Royal Army Medical Corps.
Temp. Capt. David Hardie, M.B., Royal Army Medical Corps.
Capt. Percival Hartley, Royal Army Medical Corps.
Capt. Arthur Stanley Heale, Royal Army Medical Corps.
Temp. Capt. John Thomas Hurst, M.B., Royal Army Medical Corps.
Capt. Laurence Heber Warneford Iredale, M.B., Royal Army Medical Corps, Special Reserve.
Temp. Capt. Albert Jones, M.D., Royal Army Medical Corps.
No. 37143 Serjt.-Major Arnold Kaufman, Royal Army Medical Corps.
Temp. Capt. Daniel Kelly, Royal Army Medical Corps.
Capt. Douglas Reid King, M.B., Royal Army Medical Corps, Special Reserve.
Temp. Capt. George Norman Lorimer, M.B., Royal Army Medical Corps.
Temp. Capt. John Tolmie MacKenzie, Royal Army Medical Corps.
Capt John Clifford Metcalfe, M.B., Royal Army Medical Corps.
Temp. Capt. Henry Joseph Milligan, M.D., Royal Army Medical Corps.
Capt. James Robertson Mitchell, M.B , Royal Army Medical Corps.
Temp. Capt. Henry Moore, Royal Army Medical Corps.
Capt. Richard Ernest Upton Newman, M.B., Royal Army Medical Corps.
Capt. Matthew Wallace Paterson, Royal Army Medical Corps, Special Reserve.
Temp. Capt. Arthur Starkie Plant, Royal Army Medical Corps.
Temp. Capt. Robert Arthur Welsford Proctor, Royal Army Medical Corps.
Capt. Joseph Patrick Quinn, M.B., Royal Army Medical Corps, Special Reserve.
Temp. Capt. William Kenneth Armstrong Richards, Royal Army Medical Corps.
Capt. David Jobson Scott, Royal Army Medical Corps.
Capt. Charles Frederick Searle, M.B., Royal Army Medical Corps.
Temp. Capt. Albert Davis Sharpe, M.D., Royal Army Medical Corps.
Surg.-Capt. Eric Gleadon Storrs, Rhodesian Medical Service.
Temp. Capt. Harold Saunderson Sugars, M.B., Royal Army Medical Corps.
Capt. Oskar Teichmann, Royal Army Medical Corps.
Temp. Capt. William Bunting Wamsley, M.B., Royal Army Medical Corps.
Capt. Lawder Thomas Whelan, Royal Army Medical Corps.
Capt. John St. George Wilson, Royal Army Medical Corps.

Australian Imperial Force.

Capt. Hugh William Fancourt Mitchell, Army Medical Corps.
Capt. George Seabourne Robinson, Army Medical Corps.
Capt. Charles Trevor Turner, Army Medical Corps.
Capt. Frederick Lawrence Wall, Army Medical Corps.

Canadian Force.

Capt. Richard Henry Moore Hardisty, Army Medical Corps.
Capt. Ashley Cooper Cornell Johnston, Army Medical Corps.
Lieut. (Temp. Capt.) Charles Goldie Sutherland, Army Medical Corps.
Capt. William George Turner, Army Medical Corps.

New Zealand Force.

Capt. Aubrey Vincent Short, New Zealand Medical Corps.

South African Force.

Capt. Robert Patrick McNeill, South African Medical Corps.

AWARDED THE DISTINGUISHED CONDUCT MEDAL.

No. 18830 Serjt. F. Bell, Royal Army Medical Corps.
No. 49644 Cpl. (Acting-Serjt.) J. Rigby, Royal Army Medical Corps.

AWARDED THE MERITORIOUS SERVICE MEDAL.

For valuable services rendered with the Armies in the Field:—
No. 83767 Serjt.-Major T. W. Comfort, Royal Army Medical Corps.
No. 473235 Staff-Serjt. F. Edmonds, Royal Army Medical Corps.
No. 19844 Cpl. (Acting Qmr.-Serjt.) J. Green, Royal Army Medical Corps.
No. 35072 Serjt.-Major W. Mellor, Royal Army Medical Corps.
No. 11527 Qmr.-Serjt. (Acting Serjt.-Major T. C. Prewett), Royal Army Medical Corps.
No. 16177 Serjt.-Major A. F. Robinson, Royal Army Medical Corps.
No. 33299 Pte. J. R. Whisker, Royal Army Medical Corps.

The King has been graciously pleased to confer the Decoration of the Royal Red Cross on the undermentioned Sister in Queen Alexandra's Imperial Military Nursing Service:—

First Class.

Superintending Sister Miss Flora Tindal Greig

ARMY MEDICAL SERVICE.

Col. Charles H. Hale, C.M.G., D.S.O., retires on retired pay, dated May 23, 1917.

ROYAL ARMY MEDICAL CORPS.

The undermentioned relinquish the acting rank of Lieut.-Col. on reposting:—
Dated February 12, 1917.—Major Raymond L. V. Foster, M.B.
Capt. (Temp. Major) John A. Manifold, M.B., to be Acting Lieut.-Col. whilst in command of a Stationary Hospital, dated January 21, 1917.
The undermentioned to be Acting Lieut.-Cols. whilst in command of a Casualty Clearing Station:—
Dated April 7, 1917.—Major Arthur M. MacLaughlin, M.B.
Dated April 13, 1917.—Brevet Lieut.-Col. Arthur H. Safford.
The undermentioned to be Acting Lieut.-Col. whilst in command of a Field Ambulance:—
Dated February 5, 1917.—Capt. Francis W. M. Cunningham, M.D.
Dated April 13, 1917.—Major William C. Croly.
Temp. Hon. Major George A. Benson to be Temp. Major whilst employed with Base Records Office, dated May 26, 1917.
The undermentioned to be Temp. Qmr., with the hon. rank of Lieut.:—
May 5, 1917.—Samuel Mason.
May 10, 1917.—Henry Samuel Goodchild.
May 14, 1917.—Walter Jones.
Lieut.-Col. Henry E. M. Douglas, V.C., C.M.G., D.S.O., to be temp. Col. whilst employed as Assistant Director of Medical Services of a Division, dated May 3, 1917.
Temp. Capt. Ryder P. Nash (Capt. Royal Army Medical Corps, Territorial Force), to be Acting Lieut.-Col. whilst in command of a Field Ambulance, dated March 17, 1917.
Lieut.-Col. Arthur R. Aldridge, C.S.I., C.M.G., M.B., Reserve of Officers, to be Acting Col. whilst specially employed, dated May 22, 1917.
Temp. Major William R. Dawson, M.D., F.R.C.P., to be Temp. Hon. Lieut.-Col., dated May 22, 1917.
Temp. Capt. Geoffrey P. Humphery, M.B., to be Temp. Major, dated June 3, 1917.
Capt. Owen R. McEwen to be Acting Major whilst in charge of a Base Depôt Medical Store, dated April 21, 1917,
The undermentioned to be Acting Lieut.-Cols. whilst in command of a Field Ambulance:—
Dated from May 4 to May 8, 1915.—Major Edgar E. Powell.
Dated from June 24 to August 31, 1915.—Major Arthur W. Gibson
Dated October 1, 1915.—Major Harry W. Russell, M.D.
Dated June 28, 1915.—Major Arthur W. Gibson.
Dated from March 1 to March 22, 1915, and from July 8, 1915, to May 26, 1916.—Capt. Thomas J. Mitchell, M.B.
Dated March 13, 1917.—Capt. John W. L. Scott.

Dated April 4, 1917.—Capt. George P. Taylor, M.C., M.B.

The undermentioned to be Acting Lieut.-Cols. whilst in command of a General Hospital:—

Dated August 16, 1916.—Major John G. Foster, M.B.

Dated from November 15 to December 7, 1916.—Capt. Charles E. H. Milner, T.F.

Dated from December 23, 1916, to January 12, 1917.—Major Joseph F. Whelan, M.B.

The notification in the *Gazette* of February 15, 1917, regarding Capt. C. E. H. Milner, T.F., is cancelled.

Major (Brevet Lieut.-Col.) Henry J. Crossley to be Acting Lieut.-Col. whilst in command of a Stationary Hospital, dated December 18, 1916.

The notification in the *Gazette* of March 13, 1917, regarding Capt. B. Biggar is cancelled.

Capt. B. Biggar, M.B., is seconded for service with Egyptian Army, dated March 2, 1917.

THE LATE SURGEON-GENERAL SIR WILLIAM TAYLOR, K.C.B.

Several friends and former comrades of the above officer having expressed a desire to perpetuate his memory in some suitable manner, a small Committee has been formed in order to carry out the proposal, viz.:—

Sir Alfred Keogh (Chairman),

Sir John Furley, Sir William Babtie,

Sir Launcelotte Gubbins, Col. C. R. Tyrrell (Hon. Secretary and Treasurer).

The suggestion is that the subscription should, ordinarily, be a guinea; but any larger or smaller sum will be gratefully received, and as soon as the promised amount can be approximately ascertained, a decision will be come to as to the most suitable form of memorial to be adopted.

Donations may be sent either by cheque or crossed P.O. to Col. C. R. Tyrrell, 5, The Green, Wimbledon Common, S.W., or may be paid direct (marked "Taylor Memorial Fund") to Sir Charles McGrigor Bart and Co., 39, Panton Street, Haymarket, S.W.

London, May, 1917.

MARRIAGE.

DICKSON—CUNNINGHAM.—At St. George's U.F. Church, Edinburgh, on June 5, by Professor H. R. Mackintosh, Captain Robert Milne Dickson, R.A.M.C., Bath, fourth son of William Dickson, Newport, Fife, and Kate Wilson, daughter of the late William Cunningham, Dundee, and Mrs. Cunningham, 6, Marchiston Bank Gardens, Edinburgh.

DEATH.

RYLEY.—Died in France, suddenly, on May 4, Major Charles Ryley, R.A.M.C., beloved husband of Christine Ryley, St. Denis, Camberley, and only son of the late Charles and Mary Ryley, of England and New Zealand.

EXCHANGES, &c.

The charge for inserting Notices respecting Exchanges in the Royal Army Medical Corps is 5/- for not more than five lines, which should be forwarded by Cheque or P.O.O., with the notice, to Messrs. G. STREET and CO., Ltd., 8, Serle Street, London, W.C., not later than the 22nd of the month.

A free issue of twenty-five reprints will be made to contributors of Original Communications, and of twenty-five excerpts of Lectures, Travels, and Proceedings of the United Services Medical Society.

● Any demand for excerpts, additional to the above, or for reprints, must be forwarded at the time of submission of the article for publication, and will be charged for at the following rates, and additional copies at proportionate rates:—

Number of Reprints	Number of Pages	Cost of Reprints	Cost of Excerpts *	Extra for Covers for Reprints: As Journal, Printed on Front	As Journal, Plain, Unprinted	Cheaper Paper, Printed on Front	Cheaper Paper, Plain, Unprinted
		£ s. d.	£ s. d.	s. d.	s. d.	s. d.	s. d.
12	4	0 2 9	0 1 2				
	8	0 5 0	0 2 3	4 3	1 1	3 10	0 9
	16	0 8 3	0 3 11				
25	4	0 3 4	0 1 5				
	8	0 6 0	0 2 9	4 10	1 6	4 4	0 11
	16	0 10 6	0 5 0				
50	4	0 4 6	0 1 10				
	8	0 7 6	0 3 6	5 0	2 1	4 10	1 2
	16	0 13 3	0 5 10				
100	4	0 6 0	0 3 1				
	8	0 10 0	0 4 10	7 10	3 11	6 7	2 5
	16	0 18 6	0 7 6				
200	4	0 9 6	0 4 5				
	8	0 15 0	0 6 7	10 10	7 6	9 0	4 10
	16	1 6 0	0 9 8				

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Notices.

EDITORIAL NOTICES.

The Editor will be glad to receive original communications upon professional subjects, travel, and personal experiences, etc. He will also be glad to receive items of news and information regarding matters of interest to the Corps from the various garrisons, districts, and commands at home and abroad.

Matter intended for the Corps News should reach the Editor not later than the 15th of each month for the following month's issue. Notices of Births, Marriages, and Deaths are inserted free of charge to subscribers and members of the Corps. All these communications should be written upon one side of the paper only; they should by preference be type-written, but, if not, all proper names should be written in capital letters (or printed) to avoid mistakes, and be addressed The Editor, "JOURNAL OF THE ROYAL ARMY MEDICAL CORPS," War Office, Whitehall, London, S.W.

Communications have been received from Lieutenant-Colonel O. W. A. Elsner; Majors E. K. Marten, C. W. Duggan, W. J. P. Adye-Curran, A. G. R. Foulerton; Captains R. B. Blair, F. C. Davies, R. P. Weldon, M. Morris, W. H. McKinstry, R. P. McDonnell, G. F. Petrie, J. Parkinson, S. C. Dyke, L. Colledge, H. L. Whale, F. Crosbie, G. Marshall, W. F. M. Loughnan, E. M. Cowell, H. Drummond; S. F. A. Charles, Esq.; Serjeant-Major J. McDowall; Staff-Serjeant T. Eastwood; Amara Clinical Society.

The following publications have been received:—

British: The Medical Press and Circular, Tropical Diseases Bulletin, St. Bartholomew's Hospital Journal, The Medical Journal of South Africa, The Hospital, The Research Laboratory (Parke, Davis and Co.), Guy's Hospital Gazette, Public Health, Journal of the Royal United Service Institution, Transactions of the Society of Tropical Medicine and Hygiene, The Middlesex Hospital Journal, The Journal of State Medicine, The Royal Engineers' Journal, The Practitioner.

Foreign: Revista de la Sanidad, Services de Saude Naval em Guerra, Bulletin de la Société de Pathologie Exotique, The American Journal of Syphilis, Archives de Médecine et de Pharmacie Militaires, United States Public Health Service, Bulletin of the Johns Hopkins Hospital, The Journal of Infectious Diseases, Archives Médicales Belges, Archives de Médecine et Pharmacie Navales, Bulletin de l'Institut Pasteur.

MANAGER'S NOTICES.

The JOURNAL OF THE ROYAL ARMY MEDICAL CORPS is published monthly, six months constituting one volume, a volume commencing on 1st July and 1st January of each year.

The Annual Subscription is £1 (which includes postage), and should commence either on 1st July or 1st January; but if a subscriber wishes to commence at any other month he may do so by paying for the odd months between 1st July and 1st January at the rate of 1s. 8d. (one shilling and eightpence) per copy. (All subscriptions are payable in advance.)

Single copies can be obtained at the rate of 2s. per copy.

The Corps News is also issued separately from the Journal, and can be subscribed for at the rate of 2s. (two shillings) per annum, including postage. Subscriptions should commence from 1st July each year; but if intending subscribers wish to commence from any other month, they may do so by paying for the odd months at the rate of 2d. per copy. (All subscriptions are payable in advance.)

Officers of the Royal Army Medical Corps possessing Diplomas in Public Health, etc., are kindly requested to register their special qualifications at the War Office. Letters of complaint are frequently received from officers stating that their special qualifications have not been shown in the Distribution List which is published as a supplement to the Journal in April and October of each year. As, however, the particulars of this list are supplied from official sources, officers are reminded that unless the possession of Diplomas, etc., has been registered at the War Office, no entry of such qualifications can be recorded in the Distribution List.

Letters notifying change of address should be sent to the Hon. Manager, "Journal of the Royal Army Medical Corps," War Office, Whitehall, London, S.W., and must reach there not later than the 20th of each month for the alteration to be made for the following month's issue.

It is requested that all Cheques or Postal Orders for Subscriptions to the Journal, Corps News, Reprints, etc., be crossed "Holt & Co.," and made payable to the "Hon. Manager, Journal R.A.M.C.," and not to any individual personally.

All communications for the Hon. Manager regarding subscriptions, etc., should be addressed to

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WAR OFFICE, WHITEHALL, S.W.